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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Technician at the Division of Water Purification, Bureau of Water, Chicago, Illinois, at the controls of the electron microscope.

Photomicrograph of coliform bacteria, greatly magnified.

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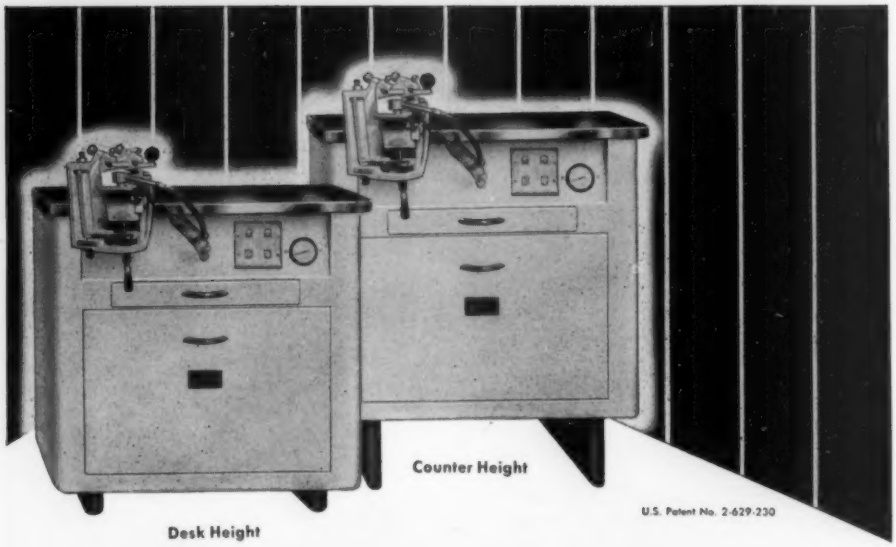

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Lifting the Lid

The generally existing concern over the lack of detailed information on the biological and other effects of radiation led the AAAS Council last December to instruct the Association's president to name a committee to study and report on that problem. Shortly thereafter the National Academy of Sciences announced the initiation of a similar, and much better financed, study. After some debate on the probability of duplication of effort, the Directors recommended, and the Council agreed, that the AAAS should keep watch over developments, but should not institute a study of its own at the present time.

There has been a good deal to watch, for 1955 has seen the publication of much more information than was made available in 1954. AEC commissioner Libby's speech in Chicago on 3 June has been widely noted and quoted. As a closer-to-home example, *Science* so far this year has published half a dozen articles on the effects—chiefly biological effects—of radiation, and will publish more on this topic. In contrast, there were practically no such articles in 1954.

Some of the information is puzzling and requires careful interpretation. Official statements have sometimes been criticized as unveiling only enough to start people guessing. A recent *Science* article on fallout was difficult to compare with a 1953 article on the same topic because the units and descriptive categories differed from those of the earlier article.

It is likely, however, that more precise information will become available. An AEC press conference called to inform reporters about the International Conference on the Peaceful Uses of Atomic Energy included an interesting colloquy between several of the reporters and the AEC representatives. Was there, the reporters wanted to know, any information that had been declassified so that it could be used in papers to be given at the Geneva meeting? No, the AEC officers replied. Was there, the reporters persisted, information in some of those papers that had not been made public before? Yes. The AEC, its officers explained, was constantly declassifying information; some would be released for the first time at Geneva; but it had not been declassified for the express purpose of using it at Geneva. That was probably the only answer that could or should have been given. Reports coming from Geneva indicate that a considerable amount of information has been released.

Interest in radiation effects is so widespread that an international study now appears probable. Ambassador Henry Cabot Lodge announced at the U.N. commemorative meeting in San Francisco that the United States would propose to the U.N. the collection and distribution of information on the effects of radiation on human health and safety. Luther Evans, director general of UNESCO, announced that UNESCO was ready to start such a survey as soon as the U.N. asked for it.

Information on the effects of radiation on plant, animal, and human life is of immense and proper concern to a society that must contemplate its future.—D.W.

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Food for the Future

J. G. Harrar

When the problem of food for the future is under discussion, a standard question concerns the extent to which science can assure that future generations will be able to enjoy an adequate standard of living from the point of view of nutrition. However, this would seem to be only part of the problem, since sufficient food for society is the concern not of the scientist alone but of all mankind. There should thus be two parts to the question: namely, what are the responsibilities of society in assuring an adequate food supply, and how can science be applied most effectively to this end?

Many competent individuals, principally demographers, biologists, and conservationists, are deeply preoccupied by the problem of maintaining a balance between food supplies and a rapidly increasing world population. It is not surprising that their conclusions range from the dismal one, that the world cannot support foreseeable increases in population, to the opposite extreme that a world population of 10 billion or even more could readily be supported from known resources. The pessimists and optimists both contribute importantly to our understanding of the world's problems, and both should be listened to with respect. However, we may be placing too much emphasis on the issues of tomorrow, while overlooking the importance of those facing us now. It seems somewhat unrealistic that we should be more concerned about generations as yet unborn than with those living today in substandard conditions. This is a little like worrying about educational opportunities for posterity while keeping one's own children home from school. If we can meet our immediate challenge successfully we will be better prepared to cope with the still larger populations to come.

Unfortunately there is a widespread attitude that problems of food production are "agency" responsibilities and are not the concern of all the instrumentalities of our society. Both present and future food requirements involve coordination between those agencies struggling to accomplish concrete results and those responsible for the political, economic, educational, and religious leadership of the world's citizenry. Each discipline and each aspect of human concern inescapably impinges on the others; and unless all these are intelligently linked, divergencies in opinion, objectives, and activities will inevitably result and will seriously impede progress.

We cannot continue to take for granted that increased food production is the exclusive worry of the scientist and that it is his obligation to find ways to satisfy growing needs and to enable mankind blithely to pursue thoughtless and careless practices in the utilization of natural resources. On the contrary, scientists can carry out their part in the total scheme only when they are working as one segment of society in harmony with the others. When each group and each individual accepts responsibilities relative to food for the future then we can make progress, and many of our present fears will disappear. In part, what demographers and scientists mean when they speak pessimistically about future food supplies is that conditions will grow worse if we blindly go on as we are in the face of an alarming population increase. This fear is justified, but need we go on as we are?

It is useless to expect that all the world will soon reach the standard of living enjoyed today by the more favored areas of the world, and we can only hope to have improvements within the limitations of the areas concerned. Some countries can continue to look forward to tremendous agricultural developments and increasing standards of living. Certain others must face the fact that they do not have large reserves of natural resources and will have to hold or improve their positions in the world community largely through the production of goods and services. Isolated material gifts to the less fortunate countries offer no permanent solution to their food problems, but types of aid that will enable them to join the other nations on a proportionately equal basis have great promise.

One of the surest ways to get at those difficulties involved in feeding present and future generations is through education. An uneducated public cannot readily understand problems that are not of visible, immediate, and local impact. Such people may be led in devious directions because of their inability to reach independent judgments and to appreciate the real consequences of their acts. Thus, food production is severely handicapped in areas where the farmers have not enjoyed the benefits of education. It is not to be expected that we can have anything approaching full agricultural production until those who till the soil are capable of making intelligent use of the improvements that modern agriculture brings. The basic approach to "food for the future" is not through the distribution of more plows but rather through the wider dissemination of knowledge. One may argue that if we follow the long route of general education, delays are inevitable and progress will be slow. Such delays, however, are insignificant in terms of "world time." The fact that educational benefits have thus far reached only small segments of society makes it all the more imperative that they be extended as rapidly as possible. Interim advances in crop production can be expected, but these will be small compared with the total benefits that can accrue when sound, mass education becomes the rule.

Real progress in mass education will lay the groundwork for other significant developments. For example, one of the greatest existing social problems is to be found in the limitations of rural life and particularly in the role of women in farm communities. The influence of rural women is vital to community progress, but as long as many millions of women

Dr. Harrar is director for agriculture of the Rockefeller Foundation, New York. This article is based on a paper that he gave on 27 Dec. 1954 in Berkeley, Calif., in the symposium on "Natural resources: power, metals, food," which comprised the first part of the AAAS symposium *Science and Society*. Other papers from the large symposium appeared in the issues of 13 May and 17 June.

are relegated to the role of farm laborers (as is tragically true in many parts of the globe) much of what they have to contribute to family life and to the training of children is lost to society. Instead, society receives only the meager product of unskilled labor. If the future is to be better, this situation will have to be changed so that coming generations will benefit from social values learned in the home, from mothers with at least basic education. At present there is an understandable monotonous similarity, from generation to generation, throughout underdeveloped areas where tradition, rather than initiative, rules.

The economics of food production and distribution is still largely in the theoretical stage, and the great benefits to be gained from the general application of sound economic theories lie ahead. In many parts of the world landholding and tenure systems are economically unsound, and these are most difficult to change. Under the system of latifundia, vast acreages lie uncultivated; whereas, by contrast, there are other regions in which the cultivation of tiny plots has become so intensive as to approach "flower pot" farming. These extremes may be the natural results of local patterns derived from varying degrees of population pressures, and we can never hope to approach maximum potential production until education and economics combine in support of scientific agriculture. Stable currencies and price policies, adequate agricultural credit, and proper marketing, all are of vital importance to a successful pattern of crop production, distribution, and utilization. When this is generally understood and accepted by society, there can be hope that all the people will be adequately fed and that the fruits of their labors will provide them with greater comforts and opportunities.

Another influence that profoundly affects food production is applied political science. Since political leaders publicly accept responsibilities for guiding the temporal thinking of the peoples of the world, their moral burdens are heavy. If we are to have food for all, political leaders will necessarily become increasingly aware of the importance of a balance between enlightened nationalism and internationalism. Otherwise, inequalities in one area may become explosive and create disturbances that may eventually become world-wide. Here again, the education and judgment of society are the most significant factors, especially since in many parts of the world democratic procedures prevail, and we select our own leaders for better or for worse. Able political leadership is usually available and will continue to be, but we must exercise our franchise with skill and perception if we are to provide ourselves with leadership of the quality necessary to meet the basic human problems.

The role of religious leadership in the solution of the problem of food for the future cannot be overestimated. Lack of understanding among religious leaders and reluctance to broaden the interpretation of their theologies in the light of increasing knowledge could be a serious obstacle to attaining a balance between populations and food production. It would seem, therefore, that the leaders of all faiths have the opportunity and obligation without sacrificing spiritual values to guide their adherents toward the understanding that, regardless of creed, human rights are equal and that they must be jealously protected. And human rights are not merely the right to a minimum of food, clothing, and shelter but rather to all of these on a reasonable scale plus opportunity in the form of education and the chance to participate in social progress.

Before the public demands greatly expanded production from agriculture it should take a hard look at its own responsibilities with regard to conservation of natural resources. In underdeveloped areas, essentially all of the limited agricultural products are utilized because of the demand for food by an underfed population; but losses to production through failure to take maximum advantage of available potentials are a serious permanent source of waste. Examples are the use of low-yielding varieties, poor cultural practices, inadequate control of pests, diseases and weeds, and failure to use fertilizers where they are needed for increased yields. Agricultural scientists could correct essentially all of these conditions in underdeveloped areas, but to be effective their activities would have to be preceded or paralleled by improvements in public health, education, and other social developments.

In areas where agricultural practice is most advanced, there is also the greatest waste of food. This may in part be an effect of economic situations that produce unused surpluses, but it is also the result of domestic habits that lead to waste. Perhaps our own country presents the most glaring example of this pattern, and it has been estimated that each year we throw away enough food to support 10 to 15 percent of our present population. Since the vast bulk of household food wastes is dumped or burned rather than recovered for agricultural or industrial purposes, their loss is total. The same situation prevails with reference to human wastes, which should be used advantageously in completing the food cycle. It seems incongruous to put heavy pressure on scientists, farmers, and resources to increase food production without requiring of society a commensurate sense of responsibility for the conservation of these products so that they will make maximum contributions to human nutrition. Similarly, we cannot complain of mounting costs and failing supplies of food and at the same time use them wastefully and continue to destroy forests, erode tremendous acreages of arable land, pollute rivers and lakes, and throw away large quantities of fossil fuels.

Many persons believe that we can meet the future with assurance, insofar as the technical aspects are concerned. Abundances of agricultural products can be obtained that would far exceed present expectations, if scientists are given a wide opportunity by society to apply their knowledge and ingenuity. There are two requisites: first, public support of pure science that will permit continuous and increased fundamental investigation of the laws of nature so that man's intellectual horizons may be constantly broadened; second, an opportunity for scientists to transmute basic knowledge into applied science, and this must be provided rapidly and be made widely available without restriction. Through the intelligent application of technical advances, an educated public can undertake to feed itself without the wanton destruction of the limited natural resources that are needed also to serve the generations to come.

If we assume that society in general will eventually meet its responsibilities relative to food for the future (and this is a major assumption), then we should carefully examine the responsibilities of science. First, the scientist must gain the confidence of nonscientists so that these two sectors of society will not be separated by barriers of fear or misunderstanding. Real progress is being made in this direction, and certainly the medical, agricultural, and other biological sciences are generally viewed as powerful social assets rather than as liabilities. A long and thoughtful view similarly convinces one that the chemical and physical sciences are equally beneficial, although the public may at times be appalled at the temporary use to which certain advances are put. It is an essential element of the scientific faith that, on a long-range basis, such developments always redound to the benefit of mankind.

We must certainly look to the physical sciences for our future supplies of energy, and nuclear energy may one day prove to be a general source of power. Progress is most rapid when vast amounts of energy are consumed, and the present hope is that power from nuclear fission will eventually replace that from other sources and make fossil fuels unimportant. Up to the present, however, mankind has derived essentially all his useful energy either directly or indirectly from the sun. Fortunately green plants were

busy storing solar energy on the earth for many eons before man came along, and our great heritage of fossil fuels, in conjunction with the radiant energy that the earth receives every day, is materially responsible for human progress. Thoughtful persons are alarmed at the rate at which we are exhausting our fossil-fuel reserves, and the most optimistic estimates give the world less than 200 years during which it may draw necessary power from coal and petroleum. If we are to continue to develop agriculture and industry, we must have sustained sources of energy on an increasing scale, and unless these are forthcoming, other questions become academic.

Significant progress has been made in learning to control nuclear reactions for the release of usable energy. There are many technologic and economic factors that must be overcome before any transition from conventional sources of energy to nuclear sources is accomplished on a large scale. There may be very much more or much less fissionable material than is currently estimated or there may be other conversion methods that may be brought into use. It has been suggested that we may eventually learn how to duplicate the sun's feat of converting hydrogen to helium with a resultant tremendous energy release in the form of gamma radiation. Any such speculation seems fantastic at the present time, even though the necessary raw materials are available in unlimited quantities. However, most major scientific developments seemed fantastic and remote before they became realities.

For many years man has dreamed of harnessing free sources of energy, including the sun, wind, tides, volcanoes, and thermal gradients of the sea. Many ingenious solar engines, heat pumps, heat exchangers, wind converters, and tide turbines have been designed and used with varying degrees of success. All these mechanisms merit further investigation, but only the sun holds promise of providing mankind with quantities of energy of the magnitude we must have in order to continue our progress. We may have been lulled to a false sense of security by our knowledge of the present reserves of oil, coal, and fissionable materials and have failed to place proper emphasis on research leading to the quantitative conversion of solar energy to forms usable in industry and agriculture. All the known reserves of coal, petroleum, and wood barely equal the total solar energy that reaches the earth every 48 hours, and conversion of relatively minute quantities to usable forms would solve our future energy problems indefinitely. The sooner we learn to use this resource, initially as a supplement, the better will be our position when at last it becomes our only major free source. It seems doubtful that the most effective way of trapping and storing solar energy is through vegetation, since photosynthesis itself is an inefficient process. Surely we can devise more efficient methods, and ultimately it should be possible to convert immense quantities of solar energy to forms that can be used immediately or stored for future power demands.

Regardless of technologic advances in other fields, we are going to be practicing agriculture for a long time, and we should learn to practice it more efficiently, if we expect to meet growing food requirements. Even though conventional agriculture as we now know it can solve present and proximate food demands, it can be further improved to the end that the possibility of a diminishing food supply can be pushed back in time. This will be accomplished as the result of continuous fundamental investigation of natural phenomena, with respect to both the physiology and biochemistry of living cells and the interrelationships between living forms and their environment. We have made extraordinary progress in agriculture by taking advantage of knowledge gained through basic research, but past applications will seem crude in comparison with refinements that may be expected in the future.

Conventional agriculture as it exists today is a far cry from the pattern of 50 or even 25 years ago. Among the most spectacular developments have been the mechanical aids. It is possible in a single operation to prepare a seedbed from unplowed land; plant, fertilize, and cultivate growing crops with the same piece of equipment, and dig root crops, pick corn, cotton, and hops; or harvest beans, cereals, and peas with mechanical devices. Harvested crops may then be washed, cleaned, frozen, or dried, and packed by other machines. These and other engineering advances have made it possible to produce uniform crops, to harvest them at exactly the right moment, and to handle huge quantities of products with minimum labor. Each year new and improved appliances are developed which enable the individual farmer to produce larger quantities of food more efficiently and at significantly lower cost. And a sound pattern of agricultural production always stimulates and supports industrial developments that absorb surplus farm labor.

The application of chemistry to agriculture has revolutionized farming. Chemical control of diseases and pests has reduced the annual crop losses significantly, and it is now possible to eliminate many weed species in cultivated crops without damaging the economic species. We can defoliate plants with one group of chemicals, hold fruit longer with others, and induce the production of seedless varieties of fruits with still others. There is also promising evidence that minute quantities of chemicals may function as protective agents within plant cells to destroy viruses and to resist attacks by fungi and insects. It is also possible that systemic chemicals may stimulate plants to produce larger quantities of stored food or valuable medicinal or industrial compounds. Similarly, it should be possible to improve both the quantity and quality of milk, meat, and eggs through the use of chemicals.

The science of genetics has proved tremendously useful in plant and animal improvement, and varieties of corn, vegetables, fruit, small grains, poultry, swine, and cattle are far superior as a result. The modern geneticist is a sort of biologic tailor who fits varieties to a specific environment, using such techniques as induced polyploidy, multiple topcrossing and backcrossing, to obtain and fix desirable characteristics and produce blended progenies. In recent years the phenomenon of hybrid vigor has been advantageously employed to increase yields, and the most spectacular example of heterosis is to be found in hybrid corn production. As the science of genetics becomes better understood, new benefits may be expected, such as increased quantities of usable products per plant, higher amino acid content, the development of dwarf varieties with increased production efficiency, as well as plants and animals endowed with greater tolerance to drouth, temperature fluctuations, and parasites.

The soils problems involved in crop production are better understood than ever before. This is true not only with regard to the role of soil biology, which has long been an almost complete mystery. New fertilizer techniques promise still greater average yields, and it is expected that progress in understanding the interaction of soil microflora and fauna will be proportionately greater during the next several decades. Another promising approach is the direct application of nutrients to foliage as an effective and economical way of feeding crop plants. Nutrient elements may be injected into the moist soils or incorporated into irrigation water with economic benefits, and chelating agents and soil conditioners are being widely tested in the hope that they may contribute toward increased average yields. And finally, soil substitutes in combination with nutrient solutions have demonstrated that under certain conditions hydroponics offer important opportunities for supplementing food production. Whether or not multistoried hydroponics gardens will, as has been suggested, be commonplace in the future will depend largely upon economic factors.

Certain of the techniques of modern

atomic physics offer fascinating possibilities for penetrating more deeply into the mysteries of cellular metabolism. The thus far limited use of the radioactive isotopes in tracer studies will in the future permit the further pinpointing of specific cellular activities and help us to understand them as parts of the metabolic process. The use of labeled elements singly and in combination permits the simultaneous study of chemical reactions within the cell. From investigations such as these we shall gain information that may help us to direct the potentialities of the cell toward the conversion of simple substances into more complex compounds of value to man. Furthermore, when crop plants are subjected to irradiations from atomic sources, spectacular changes may occur in metabolic processes. The fact that irradiation may speed up the process of mutation immediately suggests this as a method to induce cellular changes that may be of benefit. Evidence from preliminary trials indicates that dwarfing, increased productivity, and greater resistance to certain diseases may result from irradiation. Present methods are necessarily of the shotgun type, but as this tool becomes more refined it may be possible to use it more precisely and actually apply it for specific results. If, for example, such basic food crops as corn, wheat, and rice could become symbiotic nitrogen fixers, enormous increases in annual world yields would occur, with equally important reductions in costs of production. The phenomenon of symbiotic nitrogen fixation is peculiar to members of the legume family and a few other species; and why this should be true is a tantalizing mystery. There are great possibilities that induced genetic changes in conventional crop plants might increase both the quantity and quality of food production.

The use of microorganisms for the production of substantial quantities of food substances merits careful investigation. This might involve a direct approach through the use of chlorophyllous microorganisms that are relatively efficient producers of proteins and fats and the employment of methods to stimulate the activities of those species that aid in the fixation of nitrogen and other nutrient elements in soil. There is already sufficient evidence to suggest that microorganisms offer promise both as direct and indirect food sources and in the economic conversion of human wastes to usable products. The gap between the costs of the production of fuel or food energy from microorganisms and from conventional sources is still great. But as improved techniques increase production and price levels rise, this gap will tend to narrow. It seems doubtful that algae will soon be a highly competitive source of direct food in most parts of the earth, but they may be sources of proteins and fat concentrates that would be of great value in the enrichment of foods and feeds.

There is much current interest in the sea as a gigantic and relatively untapped food resource. At the moment, the amount of research going into marine biology is infinitesimal in terms of the food potentialities of the sea. But as we become more convinced of the importance of the sea as a usable resource and understand its complexities, many techniques will be evolved that will enable us to harvest vastly more food from the sea than we do today. Land is the medium of the land-dweller, and consequently the sea seems foreign and difficult. However, as our knowledge of the sea increases, ultimately it will be possible to solve many of its secrets and to "farm" the sea more intensively for human benefit.

Similarly, it is generally accepted that climate is capricious and uncontrollable. There is insufficient evidence, however, on which to base such a final conclusion, and there are at least possibilities that man can affect climatic trends in such ways as perhaps to improve both the quantities and distribution of rainfall. Any success in this area resulting from studies of cloud physics in relationship to air movements, temperature gradients, and natural barriers could have an appreciable beneficial effect on agricultural production. Rain water and ground water are at present our only sources of agricultural water and are insufficient for our demands. Effort must be made to conserve fresh waters, reclaim waste water from industry, and begin to convert sea water to semifresh water. At the moment the costs of partial desalting and transportation make this latter practice uneconomic for agricultural purposes. There is little doubt, however, that we shall eventually learn to process sea water efficiently, and when that time comes there will be an unlimited source of agricultural water available wherever such water can be economically distributed.

Summary

There is ample justification for concern about adequate food supplies for future generations of mankind, but this concern should be broadened to include the immediate problem of an adequate standard of living for the world's present population. The successful solution of the immediate problems would furnish the best background of experience for meeting those that will arise in the future. First steps include the acceptance by society of responsibilities for the extension of the benefits of education throughout the world and provision for the type of scientific, economic, social, political, and religious leadership necessary to assure food for all on a continuing basis.

Striking improvements in the food supply can be readily made through the application of present knowledge, if the foregoing conditions are met. The rapid pace of modern science, both pure and applied, gives promise that future benefits may be much greater than those thus far experienced. Current advances do not signal the end of a technical road but rather that the great scientific developments still lie ahead. If we have the intelligence and wisdom to recognize human responsibilities and to make constructive use of our natural and human resources, we can look forward to a better world in the future and improved standards of living for all.

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It is better to know a few things and to have the right use of them than to know many things which you cannot use at all.—SENECA.

Minerals for the Future

Evan Just

Since we became an industrial commonwealth, with the colossal appetite for raw materials inherent in such a way of life, the more farsighted among us have been haunted by the realization that minerals do not grow, at least over periods short enough to relate to the rate of depletion.

A moment's reflection on how all groups in our national life pin their hopes on the concept of an ever-expanding economy, will make one realize how widespread the consternation would be if it should become apparent that limited mineral supplies forebode a shrinking economy.

For more than a generation, uneasiness about depletion of minerals has caused numerous studies, largely under government auspices, directed at management of our national affairs to avoid waking up someday to discover that the raw-material base for our burgeoning economy has been eroded away.

Most of these studies have come up with ominous estimates of limited supplies which have stirred minor areas of public opinion, but the simple fact is that virtually nothing has been done in the way of altering our course. Because the older estimates have been proved to be unrealistic, a considerable group in the mineral industry scoffs at such studies.

In addition to national considerations, certain even more farseeing and less nationalistic citizens have viewed the problem on a world basis. If the rest of the world should otherwise be able to fulfill even partly its dream of industrialization and better living for all, and the world's population grows to anything approaching the fantastic numbers that experts on population trends predict, these students of mineral problems wonder how the minerals can be provided to satisfy such staggering requirements. Will mineral supplies be the bottleneck to expansion of industrialization, and if so, is it likely that a scramble for the remainder will renew jungle law among nations and the devil take the hindmost?

The realization that mineral depletion is inexorable has led some conservationists to the viewpoint that we should set aside a substantial portion of our known mineral reserve for posterity. Despite the warnings given in the afore-mentioned studies, little attention has been paid to this viewpoint. The consequences of such a course would be genuinely painful, and in the present decade the bogie of encroaching Communism would be utilized as a sufficient excuse to postpone the day of reckoning.

However, if the viewpoint is valid, and if some mineral reserves are as small as even 3 times the amounts estimated, the impact of depletion may not be a problem for remote generations. Conceivably, unless our pattern of use is quite elastic, depletion might start to curb full-employment expansionism in our children's time.

My own belief is that the means will be available to posterity to satisfy raw-material requirements for continued economic expansion and cultural progress. Nevertheless, because many think that mineral scarcities are as close to us as to our children, it behooves us to take an analytic look. The practical aspects of the problem can be treated under the following five headings.

1) *What can we expect from scientific prospecting as a means of enlarging the total available amount of economic minerals?*

Despite extensive geologic study and research by both college-trained and experience-trained men, it is still true that most of the mineral deposits in production today were found in or near outcrops by simple prospecting or by lucky accidents. Petroleum is an exception, and the finding of coal seams or other persistent sedimentary beds far from outcrops may be considered another. In the metalliferous field, the hope that geologic knowledge can be extrapolated to find hidden deposits has not yet borne fruit to an important extent. Also, except for petroleum, geophysical science has not yet brought home rewards commensurate with the efforts expended.

This situation would be all right if we still had large virgin areas to reward simple prospecting, but we do not. Most laymen would be astonished at the extent to which areas they regard as virgin wilderness have been examined many years ago. Most geologists agree that the age of discovery by simple prospecting is drawing to a close, and that we have been lucky in the way that known productive deposits have continued to pay off.

However, despite these forbidding observations, it is my own opinion that we are on the verge of an era of discoveries by scientific prospecting. Geophysical and geochemical prospecting will bring most of the earlier successes, probably enough to take care of the needs of at least the rest of the 20th century. What geologic science may do from then on, either alone or in combination with some other science, is difficult to predict, but it is certainly apparent that geology will play a useful part in the application of geophysical and geochemical methods. Scientific prospecting can be applied to extensive areas that are potentially mineral bearing but are covered with soil, alluvium, or glacial drift as well as to concealed deposits in proved areas.

This optimism is based partly on successes in the oil industry, and partly on results that have been obtained in recent years in the metalliferous field.

2) *What can we expect from more efficient extraction and processing?*

Our generation has benefited immensely from the efforts of an army of technical men who have continuously strived—successfully—to get more from deposits, to process lower grade or more refractory material, or to make utilization more efficient. These gains have been so continuous that many of us have been inclined to take them for granted.

That they will continue cannot be doubted, and in some cases the results will no doubt be as startling as the production of magnesium from sea water—a limitless source. For example, it requires only ordinary imagination to visualize in an atomic age the extraction of iron, magnesium, silicon, aluminum, soda, lime, and potash from such limitless sources as the common rocks if necessary. On the other hand, it can hardly be foreseen that technology will make such elements as copper, lead, zinc, nickel, chromium, manganese, titanium, tungsten, cobalt, tin, or the rare metals commercially extractible from such rocks. These conclusions bring us sharply up against the question: "Does a progressive civilization have to have the second group if it has access to limitless supplies the first?

3) *What can we do about reclamation of minerals and metals from wastes of various sorts?*

Every adult person has been shocked in his time by the destructive aspects of an expanding, free economy, the devastation of the forests, erosion of the soil, pollution of water and air, and the approaching exhaustion of our finest min-

Mr. Just is vice president of the Cyprus Mines Corporation, New York. This article is based on a paper that he gave on 27 Dec. 1954 in Berkeley, Calif., in the symposium on "Natural resources: power, metals, food," which comprised the first part of the AAAS symposium *Science and Society*. Other papers from the large symposium appeared in the issues of 13 May and 17 June.

eral deposits. Yet we can regrow forests if we save the soil, we can purify water, and we can rebuild soil—or even grow plants without it. We can also reclaim mineral wastes previously tossed aside or left behind.

How many of us are equally shocked at the reckless waste of metals and minerals that goes on about us, or the quantities of phosphorus, potash, and nitrogen that we run into our polluted streams? Shocked or not, we do little about it. Faced with an outpouring of nature's gifts, economic incentives have been lacking to systematize the reclamation of more than a few items. Our government has so little regard for raw-material waste that it can bring itself to sink battleships for target practice or abandon thousands of tons of equipment and supplies at distant places. Our fellow-citizens have so little concern over fuel depletion that they can devote 150 horsepower to hauling their individual persons around! And the losses through easily preventable corrosion confront us wherever we go.

However, if and when we become inclined to curb wastes, the potentialities are simply enormous. Our phosphorus supply, for example, can probably be extended tenfold by conservational measures.

4) *How much can we afford to pay for mineral supplies?*

Probably the least generally understood aspect of mineral economics is the profound effect of price on supply and demand. For example, manganese ore has been considered a potentially rare enough material to be included in our national stockpile and to call for special measures to improve the supply. This material currently sells for about 4¢ per pound. Suppose it were raised to $1.

At such a price the world's commercial reserves would be multiplied tenfold. Mining people could afford to look much farther afield and deeper. Smaller deposits of good grade would become workable, and enormous tonnages of low-grade material would be commercially exploitable. Users would be much less exacting on specifications and would undertake research toward using less. We know that they could reclaim three-fourths of what they now waste, and their bright young men could probably learn to eliminate its principal use, in steel-making. By all these reactions, the manganese supply could be made to go at least 100 times as far as it does under present conditions, and in addition it could be made nonessential.

Can we afford $1 per pound for manganese ore? At this price the national consumption would probably be below 3 pounds per capita per year—an annual cost per citizen of $3. Very few of us would ever know the difference.

Lead is another example. We currently use about 15 pounds per capita per year of new lead, which in pig form costs 15¢ per pound. It is used principally in storage batteries, gasoline, cable sheathing, acid vessels, construction, paints, glass, and weights. In all of these uses, except storage batteries, there are ready substitutes. There are substitute materials for storage batteries also, but those developed to date involve materials that are scarcer than lead. The lead in storage batteries is now 85-percent reclaimed. At $1 per pound, probably all the uses except storage batteries would largely disappear, and the lead in these would be 98-percent reclaimed. Available supplies would expand enormously. One cannot foresee depletion of lead supplies under such conditions in less than 1000 years, and the cost to the average citizen would be under $5 per year. This represents about a half-day's extra work per year to an employed citizenry that is now trying to decide whether it wants to work more than 30 hours per week! Moreover, at 98-percent recovery, the consumer would be using only 2¢ worth out of the dollar cost and returning the rest. His net cost, after allowing for collection and purification, would be under 10¢ per pound. Beyond this we have possibilities of substitution. Furthermore, the public can well afford to pay, not $1 per pound, but $20 per pound for the lead it absolutely needs. Think how far such a price would extend the supply.

On the other hand, it should be realized that no metals, even the most expensive or durable ones, are 100-percent reclaimed. High prices and serious efforts to conserve wastes will help tremendously, but they will never achieve complete reclamation.

The question of ability to pay has another interesting aspect. Today and in the past, almost everything we have built we expect to pay out in 25 years or less. This means that a single generation shoulders the cost, even though the article may last longer, in some cases for many generations. As a result, each generation enjoys a very large gift of buildings, public works, equipment, tools, materials, and other bequests from its predecessors, for which it could afford to pay its share if higher prices were necessary for the raw materials.

5) *What can we do to substitute abundant minerals and metals for scarcer ones?*

We have already touched on the feasibility, in an atomic age, of utilizing the abundant elements of the common rocks, whenever such measures become necessary. With iron, aluminum, magnesium, and silicon available in limitless supply from such sources, can it be said that we absolutely need any other metals for construction, tools, and durable goods? We can say with certainty that the metals like lead, zinc, copper, tin, and the ferro-alloys will last for hundreds of years for their most essential uses, but if they finally come to an end, there is no basis for the contention that they cannot be eliminated altogether in favor of the metals of the common rocks or ceramic materials.

As for the minerals necessary for agriculture, lime and potash are recoverable from common rocks, and known phosphorus reserves are sufficient for thousands of years, and for tens of thousands if they are conserved.

In the areas and times more clearly perceptible, it is perfectly evident that our technology has an immense capacity to find satisfactory substitutes for scarce materials. The process goes on constantly; there is no reason to anticipate its end.

Also, it is not beyond the bounds of possibility that man may learn to synthesize the elements at prices he can afford to pay for their most essential uses.

Before one adopts a more pessimistic attitude, it should be realized that neither the joy of living nor the progress of culture are dependent on multistory buildings, 60,000-ton ships, rockets, automobiles, airplanes, or radio.

To summarize the outlook for metal and mineral supplies, there seems to be no reason why we need fear that the growth of either industry, culture, or well-being need be stifled because of depletion. Reserves of the scarcer minerals can be greatly extended at costs that can easily be borne, and in the final analysis they are not necessary to the progress of civilization in any real sense. In fact, there is some basis for the idea that cultural development might proceed faster if we were less surrounded by material wealth, since it frequently seems to be our master instead of our servant.

The harsh statements made about waste in the foregoing paragraphs and the conclusion that posterity will not be in jeopardy for mineral resources may appear to be in conflict. Should we take special action to prevent waste or should we carry on along our present course of conserving only where it pays?

To acknowledge that the survival of posterity is not fundamentally dependent in our self-denial does not mean that our successors are not handicapped by our wastefulness. Probably they will be, even though they can continue to enjoy material well-being by added effort. It would seem then, to be fair play to exercise, through educational measures rather than compulsions, a certain restraint in despoiling the earth of its treasures. Moreover, speaking strictly in our own behalf, all human experience indicates that curbing of our appetites is good for our own characters.

Acyl Derivatives of Glyceraldehyde-3-Phosphate Dehydrogenase

I. Krimsky and E. Racker

Studies of the mechanism of enzyme action have been hampered by difficulties encountered in the isolation of compounds or complexes that may result from interaction of enzymes with their substrates. The availability of glyceraldehyde-3-phosphate dehydrogenase in large quantities has made it possible to use this enzyme not only as a catalyst but, in micromolar amounts, as a reactant. From these studies, which are briefly reviewed here, it has become clear that under certain conditions the enzyme-substrate compound can be stabilized and isolated. The isolation and properties of the crystalline enzyme-substrate intermediate are the subject of this article (*1*).

Mechanism of Action of Glyceraldehyde-3-Phosphate Dehydrogenase

The mechanism of the reversible oxidation and phosphorylation of aldehydes to acyl phosphates by glyceraldehyde-3-phosphate dehydrogenase has been extensively investigated in recent years. An early theory (*2, 3*) postulated a nonenzymatic addition of phosphate to glyceraldehyde-3-phosphate followed by enzymatic oxidation of the hypothetical diphosphoglyceraldehyde to 1,3-diphosphoglyceric acid. In spite of various attempts (*4*), no evidence for the operation of this mechanism during the enzymatic oxidation of glyceraldehyde-3-phosphate has been obtained.

In analogy with the glyoxalase reaction, an alternative theory has been presented (*5, 6*) involving the intermediate formation of a thiol ester. In the proposed sequence of events (Fig. 1), a DPN-enzyme compound (I) interacts with the aldehyde substrate to yield reduced DPN and an acyl enzyme (II) wherein the acyl moiety of the oxidized substrate is attached to a sulfur atom of the protein; this thiol ester is split by inorganic phosphate to yield acyl phosphate and regenerated SH-enzyme (III). Evidence consistent with the essential features of this formulation of the mechanism of enzyme action has been brought forward from a number of laboratories (*6, 7*).

The enzyme as isolated from muscle (*8*) contains firmly bound DPN (*9*). In "reduced" (*10*) enzymes, 3 moles of DPN are bound to each mole of enzyme. (This can be shown either by reducing the DPN on the enzyme with glyceraldehyde-3-phosphate or by precipitating the enzyme with trichloracetic acid and measuring the amount of released DPN in the supernatant fluid.)

The enzyme as isolated from rabbit muscle under conditions that prevent oxidation of sulfhydryl groups (*11*) has an absorption with a broad maximum around 360 mμ. This absorption depends on the presence of bound DPN and SH groups. It disappears when the DPN is removed (by treatment with charcoal) and is restored by the addition of 3 equivalents of DPN. It also disappears when the SH groups are blocked or oxidized, or after addition of the substrates, acetyl phosphate or 1,3-diphosphoglycerate, thus indicating the participation of the DPN-enzyme complex in the enzyme catalyzed reaction (*6*). Similar data have been obtained with yeast enzyme in the presence of DPN.

That the DPN-enzyme complex is directly involved in the activity of the enzyme is also indicated by the fact that disappearance of the absorption at 360 mμ on addition of iodoacetate is closely paralleled by loss of enzymatic activity. After the addition of 3 equivalents of iodoacetate, there is no further reduction in the absorption at 360 mμ. The same amount is needed for complete inactivation of the enzyme (*12*). Inhibition of glyceraldehyde-3-phosphate dehydrogenase activity by irreversible SH blocking reagents, such as iodoacetate and *N*-ethyl maleimide, can be prevented for a time by substrates or by substrate analogs (*13*).

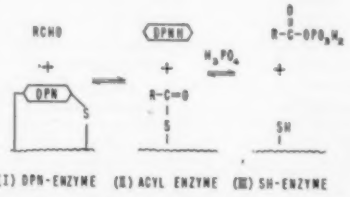

Fig. 1. Mechanism of aldehyde oxidation by glyceraldehyde-3-phosphate dehydrogenase.

Approximately 2 equivalents of glutathione (as measured by glutathione reductase) are released from glyceraldehyde-3-phosphate dehydrogenase by tryptic digestion. (The method used precludes complete recovery of glutathione.) Treatment of the enzyme with 3 equivalents of iodoacetate preceding digestion prevents the appearance of free glutathione. This parallels the afore-mentioned inhibition of over-all enzyme activity. Similarly, formation of thiol ester (acyl enzyme) by the interaction of acetyl phosphate and the enzyme is suppressed by 2 to 3 equivalents of iodoacetate (*14*).

Isolation and Properties of Acyl Enzyme

It was recently found that the formation of acyl enzyme (II) from the acyl phosphate (III) occurs with enzyme free of DPN and that the resulting acyl enzyme had considerable stability as compared with similar preparations obtained in the presence of DPN (*15*). Kinetic and spectrophotometric evidence for the formation of an acyl enzyme was advanced from several laboratories (*6, 7*), but the isolation of the enzyme-substrate compound had not been reported previously. Efforts were therefore directed toward the isolation of this postulated enzyme derivative. The observations on the stabilization of acyl enzyme by removal of DPN made it possible to isolate the acyl derivative of the enzyme.

Acetyl and 3-phosphoglyceryl enzyme have been prepared from glyceraldehyde-3-phosphate dehydrogenase isolated from both rabbit muscle (*8*) and baker's yeast (*16*) in the presence of ethylene diamine tetraacetate. The muscle enzyme was treated once or twice with 40 mg of charcoal per milliliter of a 3 to 6 percent solution to remove bound DPN; recrystallized glyceraldehyde-3-phosphate dehydrogenase from yeast is sufficiently free of DPN.

Either acetyl phosphate or a mixture of 3-phosphoglycerate, ATP, Mg^{++}, and phosphoglycerate kinase were incubated with the enzyme for a few minutes at *p*H 7; the protein was precipitated by addition of a cold saturated solution of ammonium sulfate at *p*H 6, the mixture was centrifuged, and the sediment was washed several times with saturated ammonium sulfate solution. Finally, the sediment was dissolved in a small amount of cold water. The protein crystallized

Dr. Krimsky and Dr. Racker are on the staff of the Public Health Research Institute of the City of New York, Inc., New York 9, N.Y.

during the washing procedure; also, it was readily recrystallized from solution by the addition of ammonium sulfate.

Like thiol esters, the acyl enzymes reacted with hydroxylamine at *p*H 6.5 to form hydroxamic acids. The acyl-enzyme bond of acetyl enzyme was, like the thiol ester of acetyl glutathione, stable to heating at 100° C for 5 min at *p*H 4.5. The thiol ester of phosphoglyceryl enzyme was found to be destroyed by this treatment. The thiol ester bond of both acetyl and phosphoglyceryl enzyme was stable in cold 5-percent trichloracetic acid. Formation of the acyl enzymes was prevented by treatment of the enzymes with approximately 3 equivalents of either iodoacetate (in the presence of DPN) or *N*-ethyl maleimide (in the absence of DPN) before mixing with the substrates. The acyl enzymes were sufficiently stable in the cold at neutral *p*H to permit study of their enzymatic properties; they lost approximately 30 percent of their hydroxamic acid-forming capability in the course of 4 hr at 0° C. Under the aforedescribed conditions for the preparation of the acyl enzymes, 0.8 to 1.5 moles of acyl groups (measured as hydroxamic acid) were found to be present per mole of enzyme.

The acyl enzymes oxidized DPNH in amounts approximately equivalent to the amounts of hydroxamic acid they could form, as is shown in Table 1. (The absorption coefficient of phosphoglyceryl hydroxamic acid-Fe complex is here assumed to be that of acetyl hydroxamic-Fe complex.) In the case of acetyl enzyme, an additional amount of DPNH was oxidized on adding alcohol dehydrogenase to the mixture. It may be assumed, then, that the acetyl group of acetyl enzyme was reduced to acetaldehyde, which in turn was reduced to ethanol. Similarly, in the case of phosphoglyceryl enzyme, addition of triose phosphate isomerase and α-glycerophosphate dehydrogenase caused further oxidation of DPNH; here, glyceraldehyde-3-phosphate formed by reduction of the phosphoglyceryl group was isomerized to dihydroxyacetone phosphate, which was then reduced to α-glycerophosphate. The oxidation of DPNH by phosphoglyceryl enzyme from yeast and muscle and by acetyl enzyme from muscle is rapid; oxidation of DPNH by acetyl enzyme from yeast is slow. These rates are in good agreement with the rates of oxidation of DPNH by the two acyl phosphates in the presence of catalytic amounts of the enzymes.

Figure 2 illustrates an experiment in which phosphoglyceryl enzyme prepared from muscle glyceraldehyde-3-phosphate dehydrogenase was used to oxidize DPNH. The first point in the curve represents the optical density at 340 mμ calculated from the density of the enzyme solution plus that of DPNH, which was added last. The acyl enzyme caused a rapid oxidation of DPNH during the first minute in contrast to the control, in which acylation of the enzyme was prevented by prior treatment with *N*-ethyl maleimide. The slow oxidation of DPNH that follows may be explained by trace contamination of the glyceraldehyde-3-phosphate dehydrogenase (7.5 mg of enzyme was used) with triose phosphate isomerase and α-glycerophosphate dehydrogenase. Addition of triose phosphate isomerase and α-glycerophosphate dehydrogenase caused a further sharp decrease in DPNH, corresponding approximately to the theoretical amount of triose formed from phosphoglyceryl enzyme.

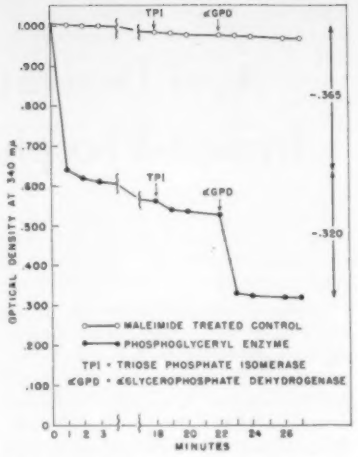

Fig. 2. Oxidation of reduced DPN by phosphoglyceryl enzyme.

Arsenolysis and Hydrolysis of Acyl Enzyme

It is known that arsenate can substitute for phosphate in the enzyme catalyzed oxidation of glyceraldehyde-3-phosphate by DPN (*2*). However, in the presence of arsenate, an equilibrium mixture of aldehyde and acyl compound is not obtained; instead the oxidation of the aldehyde to the free acid goes to completion, presumably because of the spontaneous hydrolysis of the hypothetical acyl arsenate. In the presence of arsenate, acetyl phosphate and 1,3-diphosphoglycerate are rapidly hydrolyzed by glyceraldehyde-3-phosphate dehydrogenase. This arsenolysis has been shown to depend on DPN (*6*).

"Oxidized" (*10*) glyceraldehyde-3-phosphate dehydrogenase catalyzes a DPN-dependent hydrolysis of acetyl phosphate; glutathione or potassium cyanide inhibited this reaction without inhibiting arsenolysis (*17*). In the course of the present investigation it was found that preparations of "reduced" (*10*) enzyme likewise exhibit hydrolytic activity which is relatively slow compared with the rate of arsenolysis. Hydrolysis is accelerated by prior treatment of the enzyme with iodoacetate in contrast to arsenolysis, which is inhibited. On the other hand, potassium cyanide and glutathione, as well as semicarbazide, phenyl hydrazine, and hydroxylamine, inhibited hydrolysis of acetyl phosphate by iodoacetate-treated or untreated enzyme without affecting the rate of arsenolysis of acetyl phosphate by untreated enzyme. They also stabilize acyl enzyme in the presence of DPN against hydrolysis but do not prevent the very rapid arsenolysis of the acyl enzyme. A typical experiment is shown in Table 2 demonstrating the effectiveness of the inhibitors in stabilizing the acyl groups. Since these inhibitors are known to react with carbonyl groups, the possibility was considered that an aldehyde group of the enzyme participates in the hydrolytic activity. It was found that heating of the neutral protein solution at 100°C released a small amount of steam-distillable aldehyde, which served as substrate for alcohol dehydrogenase in the presence of DPNH. Since several other highly purified proteins also yielded an aldehyde after heat denaturation, the relation of the released

Table 1. Comparison of hydroxamic acid formed and DPNH oxidized by equal amounts of acyl enzyme.

Acyl enzyme	Hydroxamic acid (moles per mole of glyceraldehye-3-phosphate dehydrogenase*)	DPNH oxidized (moles per mole of glyceraldehyde-3-phosphate dehydrogenase*)
Acetyl (muscle)	0.80	0.82
Phosphoglyceryl (muscle)	0.96	1.04
Acetyl (yeast)	0.87	0.46†
Phosphoglyceryl (yeast)	0.78	0.60‡

* The molecular weight of the enzyme is taken as 120,000 (*18*).
† Minimum figure (oxidation incomplete after 3 hr).
‡ DPNH oxidation was measured about 2 hr after hydroxamic acid formation.

Table 2. Stabilization of phosphoglyceryl enzyme (muscle) in the presence of DPN by aldehyde reagents.

Additions	Decomposition of acyl enzyme in 12 min at 25°C (%)
None	53
Potassium cyanide (0.001/*M*)	0
Glutathione (0.001*M*)	0
Semicarbazide (0.03*M*)	6
Phenyl hydrazine (0.03*M*)	22

aldehyde to the hydrolysis of acyl groups remains to be elucidated.

Summary

Acetyl phosphate and 1,3-diphosphoglycerate react with glyceraldehyde-3-phosphate dehydrogenase to form relatively stable enzyme substrate compounds. These compounds appear to be thiol esters, and their properties indicate that they are intermediates in the catalytic activity of the enzyme: they undergo hydrolysis and arsenolysis in the presence of DPN and are reduced by DPNH to form aldehydes. These results are in agreement with the mechanism previously proposed for the oxidation of aldehydes in which a thiol ester formed on the enzyme, with concomitant reduction of DPN, is split in the presence of phosphate to acyl phosphate and regenerated enzyme.

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I cannot refrain from marveling that Sarsi will persist in proving to me, by authorities, that which at any moment I can bring to the test of experiment. We examine witnesses in things which are doubtful, past, and not permanent, but not in those things which are done in our own presence. If discussing a difficult problem were like carrying a weight, since several horses will carry more sacks of corn than one alone will, I would agree that many reasoners avail more than one; but discoursing is like coursing, and not like carrying, and one barb by himself will run farther than a hundred Friesland horses. When Sarsi brings up such a multitude of authors, it does not seem to me that he in the least degree strengthens his own conclusions, but he ennobles the cause of Signor Mario and myself, by showing that we reason better than many men of established reputation. If Sarsi insists that I must believe, on Suidas's credit, that the Babylonians cooked eggs by swiftly whirling them in a sling, I will believe it; but I must say, that the cause of such an effect is very remote from that to which it is attributed, and to find the true cause I shall reason thus. If an effect does not follow with us which followed with others at another time, it is because, in our experiment, something is wanting which was the cause of the former success; and if one thing is wanting to us, that one thing is the true cause. Now we have eggs, and slings, and strong men to whirl them, and yet they will not become cooked; nay, if they were hot at first they more quickly become cold; and since nothing is wanting to us but to be Babylonians, it follows that being Babylonians is the true cause why the eggs become cooked, and not the friction of the air, which is what I wish to prove. Is it possible that in traveling post, Sarsi has never noticed what freshness is occasioned on the face by the continued change of air? And if he has felt it, will he rather trust the relation by others of what was done two thousand years ago at Babylon, than what he can at this moment verify in his own person? I, at least, will not be so wilfully wrong and so ungrateful to nature and to God, that having been gifted with sense and language I should voluntarily set less value on such great endowments than on the fallacies of a fellow-man, and blindly and blunderingly believe whatever I hear, and barter the freedom of my intellect for slavery to one as liable to error as myself.
—GALILEO GALILEI, *Il Saggiatore*. 1623. Translated by Giorgio De Santillana.

News of Science

Earth Satellite

Plans for the construction of a small, unmanned, earth-circling satellite vehicle to be used for basic scientific observations during the forthcoming International Geophysical Year (IGY) were announced at the White House on 29 July by Detlev W. Bronk, president of the National Academy of Sciences, and Alan T. Waterman, director of the National Science Foundation. Scientists expect to complete the satellite developmental work in time for a successful launching of one or more vehicles during the IGY, a period selected during 1957 and 1958 for world-wide observations in the fields of the earth sciences by some 40 nations.

The satellite program was initiated in compliance with a resolution passed by the Special Committee for the International Geophysical Year (the "CSAGI") at its Rome meeting in Oct. 1954. The resolution reads: "In view of the great importance of observations during extended periods of time of extraterrestrial radiations and geophysical phenomena in the upper atmosphere, and in view of the advanced state of present rocket techniques, CSAGI recommends that thought be given to the launching of small satellite vehicles, to their scientific instrumentation, and to the new problems associated with satellite experiments, such as power supply, telemetering, and orientation of the vehicle." Similar resolutions were adopted in Sept. 1954 at meetings of the International Union of Geodesy and Geophysics and the International Scientific Radio Union.

The satellite, intended specifically and entirely for scientific uses, is being developed with the technical advice and assistance of scientists who have long been engaged in research on the upper atmosphere. The White House announcement said that the Department of Defense will provide the required equipment and facilities for launching.

Formal notification of the inclusion of the satellite project in this country's IGY program was communicated to Sydney Chapman, president of CSAGI, by Joseph Kaplan, chairman of the U.S. National Committee for the IGY. Kaplan wrote: "The participation of other nations engaged in the International Geophysical Year program is invited, and to this end we shall provide full scientific information on the orbiting vehicle so that other nations may monitor the device and make appropriate observations."

Once established in its orbit, the satellite will be able to telemeter information to earth about conditions in the outer edge of the atmosphere. It can also report on extraterrestrial radiations and particles that are shielded by the earth's atmosphere—ultraviolet radiation, cosmic rays, meteors, and so forth—that have a strong influence on the upper atmosphere and indirectly affect the lower atmosphere.

In the past, vertical rocket flights to extreme altitudes have provided considerable information about the upper atmosphere, but such flights are limited to very short periods of time. Only by use of a satellite can sustained observations in both space and time be achieved. Plans are being made for a basketball-sized vehicle that will orbit around the earth for a period of days at a height of 200 to 300 mi and at a velocity of 18,000 mi/hr, gradually circling back into the upper atmosphere where it will eventually disintegrate harmlessly.

The satellite project is one important part of the United States plans for scientific work during the IGY, when scientists will conduct the most comprehensive study of the earth ever undertaken. Intensive investigations throughout the world will be carried out in meteorology, latitude and longitude determinations, geomagnetism, gravity measurements, ionospheric physics, aurora and airglow, solar activity, cosmic rays, glaciology, oceanography, seismology, and rocket exploration of the upper atmosphere.

Each of the fields in the program is characterized by its global nature, and many are related to solar-energy fluctuations and disturbances. There will be special emphasis on observations from locations that are usually inaccessible, such as Antarctica—and now from satellites. Measurements must be made simultaneously so that the relationships between fields can be determined on the basis of world-wide coverage.

The list of nations that will participate in the IGY program includes: Argentina, Australia, Austria, Belgium, Brazil, Burma, Canada, Chile, Czechoslovakia, Denmark, Finland, France, East Germany, West Germany, Great Britain, Greece, Hungary, Iceland, India, Ireland, Israel, Italy, Japan, Mexico, Morocco, Netherlands, New Zealand, Norway, Pakistan, Peru, Philippines, Spain, Sweden, Switzerland, Thailand, Tunisia, Union of South Africa, U.S.S.R., United States, and Yugoslavia. Each country will plan and execute its own program, under a general plan developed and coordinated by the Special Committee for the International Geophysical Year.

The U.S. National Committee for IGY, established by the National Academy of Sciences, is in charge of planning, directing, and executing this country's program. The committee and its technical panels, which include many of the nation's leading geophysicists, have developed the program in cooperation with a number of universities, institutions, and agencies. Federal sponsorship and support has been obtained by the committee through the National Science Foundation.

Secrecy in the Sky

The following excerpts are drawn from an editorial entitled "Secrecy in the Sky" that appeared in the 4 Aug. issue of the *New York Times*.

"A few Senatorial voices have been raised to protest against the President's intention to tell the world . . . what information may be telemetered to ground stations by the artificial satellites that are to be sent up in 1957 or 1958. . . . For years we clung to secrets that were no secrets at all. If we paid any attention to the protesting Senators, our physicists and engineers would have nothing to say at the atoms-for-peace conference in Geneva . . .

"If the Soviet Union plants a satellite in the sky . . . it will find out as much as we can about the frontier of outer space. . . .

"It would be a mistake not to publish all that we may discover about the conditions that prevail 250 miles away from the earth, even though something of indirect military use may be important. More important is the preservation of the spirit that the President infused in the recent "summit" conference at Geneva. His willingness to pool our knowledge of the atom with that of other nations for mankind's benefit, the emphasis that he has laid on the peaceful uses of the atom and now his proposal to make the knowledge to be gained by an artificial satellite common property, is all in the high tradition of science.

"Too long have scientists been muzzled by following a policy of secrecy necessary only as far as strictly military matters are concerned. The President has taken an immense forward step by restoring freedom of scientific discussion to its old state."

Krebiozen

On 2 Aug. Andrew C. Ivy, a former vice president of the University of Illinois, filed a $360,000 libel suit in the State Supreme Court, New York, against George D. Stoddard, former president of the University of Illinois. The suit is based on some 50 passages that are included in a book by Stoddard entitled *Krebiozen: The Great Cancer Mystery.*

The complaint explains that Ivy is studying Krebiozen, which he believes shows promise as a treatment for cancer, and that as a result of Stoddard's writings Ivy has been "shunned by scientists and medical doctors, excluded from their meetings and from the lecture programs to which he [has] frequently been invited in the past as a lecturer . . . and his professional papers on scientific subjects [have] been rejected by scientific journals."

The Krebiozen issue arose more than 4 years ago when the substance was first announced. Ivy's failure at that time to disclose the nature of the drug led to his suspension for 3 mo from the Chicago Medical Society. After both the American Medical Association and the National Research Council had reported unfavorably on Krebiozen, and after the submission of a report by a specially appointed university committee, President Stoddard banned further research with the material and arranged that Ivy take a leave of absence.

Several months later, on 31 Aug. 1953, Stoddard was forced to resign his presidency as the result of a 6-to-3 "no confidence" vote by the university's board of trustees. Some 20 department heads joined together to condemn publicly the action of the board and to thank Stoddard for his "stand for honesty in science and integrity in education." By early September Ivy had returned to his post as head of the department of clinical science, with the title of distinguished professor of physiology. He resumed his work with Krebiozen, but not under the auspices of the university.

Stoddard's book is an account of the controversy at the University of Illinois over Krebiozen. The manuscript was ready to go to press when, on 6 Apr., Judge Joseph Hurley of Massachusetts Superior Court issued an *ex-parte* restraining order to stop publication of the book by Beacon Press, Boston. *Ex-parte* means that the order was granted without hearing the case for the defense. In addition to Ivy, plaintiffs in the action were Stevan Durovic, who developed Krebiozen; his brother Marko; and the Krebiozen Research Foundation, an Illinois corporation.

Commenting editorially on the case, the Chicago *Tribune* said on 11 Apr.: "Restraint prior to publication is the most vicious form of censorship, held to be unconstitutional a quarter of a century ago by the United States Supreme Court." The publication date, originally 18 May, was postponed pending the court's decision. The 7 May issue of the *Publisher's Weekly* pointed out that the "restraining order stopping publication is believed to be the first of its kind in recent publishing history," and an editorial in the 25 June *Weekly* was entitled "Frightening Case of Censorship."

At a hearing on the application for preliminary injunction, the counsel for Beacon Press presented a vigorous demurrer asserting that to grant such an injunction would be in violation of the constitutional guarantee of freedom of the press. At the subsequent hearing on the constitutionality issue, held 15 June, both the American Book Publishers Council and the American Civil Liberties Union filed *amicus curiae* briefs supporting the request of Beacon Press that the court deny the application for a preliminary injunction.

The ABPC brief stated that ". . . publication and distribution of books of serious import and dealing with subject matter of public concern should not be prevented because of a few handpicked, allegedly defamatory statements contained in that book. We submit that there is here at stake not only the respective rights of the private litigants, but indeed fundamental rights of the public at large."

According to the *Publishers Weekly*, "Beacon Press has made an exhaustive check of the statements in Dr. Stoddard's manuscript." The book is approximately half narrative and half substantiating documents, including evidence presented before the Illinois Legislature's investigation of charges that a conspiracy existed to prevent the distribution of Krebiozen. Although this investigation took place at about the time of Stoddard's resignation, no report has yet been released; however, a preliminary report indicated that no conspiracy had been found.

On 7 July Judge Hurley ruled against the plaintiff's plea for a preliminary injunction and dissolved the restraining order that he had issued on 6 Apr. On 15 Aug. Beacon released *Krebiozen: The Great Cancer Myster.*

National Geographic-Palomar Sky Survey

The first section of an atlas of the universe, farthest-reaching map ever attempted, is being published by Palomar Observatory after almost 7 years' work, the National Geographic Society and California Institute of Technology announced on 31 July. The National Geographic Society–Palomar Observatory Sky Survey, begun in 1949, has mapped three-quarters of the sky—all that can be seen from Palomar—out to an unprecedented depth in space of 600 million light-years.

Many of the space regions photographed in detail by Palomar's 48-in. Schmidt telescope have never been seen before by astronomers. Now an over-all picture of the universe has been provided to distances beyond range of all but the largest telescopes. Observatories around the world are being sent the first 200 photo sky charts.

The total atlas will comprise 1758 photomaps when it is finished in 1956. Price per copy, covering only printing costs, is about $2000. Nearly 100 have been ordered. Each plate of the atlas is 14 in. square. The original plates now are locked three floors underground in Pasadena, Calif., and a duplicate set is buried beneath the dome of the Hale telescope at Palomar Observatory. Copies being mailed out to institutions that requested the atlas before a deadline last October are negative prints on double-weight photographic paper. Stars and other bodies in the heavens show as dark spots against a light background, for astronomers find it easier to measure the brightness of objects on such charts than on positive prints.

The National Geographic Society has borne the costs of materials as well as astronomers' salaries; observing time for the survey was provided by Palomar. General supervision of the project has been carried out by an advisory committee consisting of Lee DuBridge and Ira S. Bowen, representing C.I.T., and John Oliver La Gorce and Lyman J. Briggs, representing National Geographic. Bowen has written an article describing the mapping project for the current *National Geographic Magazine.*

The atlas offers new clues to the size of the universe, how it is made up, how old it is. New celestial bodies—comets, asteroids, stars, and island galaxies like the Milky Way—have been found. The skies have been carefully photographed for all objects down to a brightness only one one-millionth of that of the faintest star that the naked eye can see on a dark moonless night.

From the survey, astronomers will be able to determine more clearly the shape of the Milky Way. Furthermore, far beyond in outer space there are galaxies similar to the Milky Way. Sometimes they group into clusters. Although only a scant 3 dozen such clusters were known before the survey, now more than 1000 have been found. They may point to a new general law of nature governing the organization of matter in the universe.

Temperature, color, and brilliance of distant stars will be better known because

the Palomar group photographed each section of the sky twice, once in blue light and again in red light. More may thus be learned about the novae and supernovae. In contrast, dark clouds of gas and dust in space, first seen clearly on the survey's plates, may show stars in process of being born.

Years of study will bring many more discoveries. DuBridge predicts that the new atlas will be "an astronomical bible for 100 years." By analysis of light from the distant clusters of galaxies discovered on the survey's photographs, additional evidence is being obtained on the question of whether or not the entire universe is expanding, with objects racing outward like fragments from a bomb.

The late Edwin P. Hubble of Mount Wilson and Palomar found, 30 years ago, that this apparent recession obeyed a simple law—speed seemed to increase in direct proportion to distance. To test the law, galaxies farther and farther away must be measured. Milton L. Humason, working from the survey plates, has found clusters of galaxies receding at about 38,000 mi/sec—one-fifth of the speed of light. The ages of the stars, and of the universe itself, will someday be better understood because of the new atlas.

News Briefs

■ Otto A. Kuhl, W. Ralph Singleton, and Bernard Manowitz of the Brookhaven National Laboratory have developed a portable radiation unit for use in the field to induce mutations in plants. When not in use, the radioactive cobalt source is housed in a 1-ton steel and lead shield. The unit can be produced for approximately $5000.

■ Operations carried on in the east wing of the U.S. Department of Agriculture's administration building involving certain livestock diseases transmissible to man were suspended on 1 July because of hazards to the health of those engaged in the work. The work included research on tuberculosis, anthrax, and other diseases that can affect human beings. The action was taken by research administrator Byron T. Shaw on recommendation of three research scientists who recently made an inspection, at Shaw's request, of the east-wing laboratories.

The men who made the recommendation were LeRoy Fothergill, U.S. Army, Camp Detrick, Md.; William H. Feldman, Mayo Foundation, Rochester, Minn.; and Byron J. Olson, National Institutes of Health, Washington, D.C. The action was taken as a precautionary measure, since the health record in the laboratories has been very good. In the 50 years that research on anthrax has been going on, no case of this disease has been reported among workers in the east wing. In the more than 60 years since the USDA began making tuberculin there have been four cases of tuberculosis among laboratory employees. Only one of these cases was found to have resulted from official work. The suspension order involves only animal disease work that has been carried out in the administration building in Washington.

■ The University of California's Los Alamos Scientific Laboratory announced 16 July the completion of a scintillation detector large enough to accommodate a human body and to measure its accumulated amount of radioactivity. The project has been carried out under direction of the biomedical research group of the laboratory's health division and was shown in operation for the first time during the laboratory's open house 16–17 July.

By use of the scintillation detector, or "human counter," it is possible to measure radioactivity naturally present in the body. Study of this natural level of radioactivity is useful in determining how much radiation exposure is permissible. Measurements have been made at the Los Alamos laboratory of the natural potassium radioactivity of a number of subjects.

It is also necessary to guard against the possible ingestion and inhalation of radioactivity for the protection of personnel working with radioactive materials. The new instrument can be used to determine the amount of radioactivity that might have accumulated in the bodies of exposed personnel by direct measurement of gamma rays from the human body.

The scintillation detector is a cylindrical tank 6 ft long and 28 in. in diameter. Through it runs a cavity large enough to contain the human subject to be measured. The walls of the tank contain a liquid that gives off minute flashes of light when gamma rays from the person pass through it. This light is detected and amplified by 108 photomultiplier tubes installed in the outer wall of the tank. Electronic instruments record the number of gamma rays registered. The entire tank is surrounded by a 10-ton lead shield to reduce interference by external radioactivities.

The first human counter at the Los Alamos laboratory was a modification of a counter designed for a current laboratory experiment to detect the neutrino. Measurements of human radioactivity made with this apparatus in January 1953 proved that the device was feasible for this purpose. The present improved version was designed during 1953, and construction was begun in the spring of 1954.

■ The Atomic Energy Commission issued the following statement on 4 Aug.: "Within the past few days the Soviets have resumed testing of nuclear weapons. This may mean the beginning of a new test series."

■ V. D. Hopper, senior lecturer of Melbourne University's physics department, stated at a recent news conference that radioactive clouds were circling the earth at altitudes as low as 20,000 ft.

He said that four different consignments of special photographic film that is sensitive to radioactivity had been ruined when flown through the clouds en route from London to Melbourne.

■ Three British professors are to lecture at Moscow University this fall: Paul Dirac of Cambridge University, physicist and Nobel prize winner; William Astbury of Leeds University, an expert on textile physics; and Peter Medawar of London University, biologist. The lectures are part of an exchange arrangement. A Soviet natural scientist, Vladimir Engelhardt, lectured at London University this past spring.

■ The United Nations has announced that 13 Asian experts are to visit the Soviet Union soon to study mining and geology. Specialists in those fields from Afghanistan, Burma, Hong Kong, India, Indonesia, and Japan left New Delhi 2 Aug. on a 13-wk tour of the Soviet Union, Britain, France, and West and East Germany.

The UN technical assistance fund is paying all their expenses except when countries along the way are sharing the cost. The Technical Assistance Administration in New York and the UN Economic Commission for Asia and the Far East in Bangkok, Thailand, organized the project and are sending three representatives.

The group's itinerary includes Kabul, Afghanistan; Moscow; Sverdlovsk, Chelyabinsk, and Kustanai in the Urals; Samarkand and Tashkent, Uzbekistan; Dnepropetrovsk, Krivoi Rog, Zaporozhe, Kremenchug, and Kiev in the Ukraine; and Leningrad.

■ East Germany has agreed to allow a University of Pennsylvania scientist to spend "a couple of months" studying ancient Mesopotamian tablets at the University of Jena. Samuel Noah Kramer, cuneiformist, who is Clark research professor of Assyriology at Pennsylvania and curator of the tablet collection of the University Museum, has applied for a passport and hopes to reach Jena late in September.

Sanction for Kramer's trip into East Germany came from the Secretariat for Institutions of Higher Learning of the

Government of the German Democratic Republic. Last March Kramer wrote directly to Johannes Becker, East German Minister of Culture at East Berlin, whose name he had learned from a newspaper story. A reply came 3 mo later from the director of the Section for Relations of Institutions of Higher Learning with Foreign Lands.

Kramer has devoted some 25 years to fitting together and translating the Sumerian tablets, thus bringing to light some of mankind's earliest myths, epics, hymns, proverbs, laws, and even medical prescriptions. But most of the tablets are fragments, and Kramer hopes to find some of the missing pieces at Jena.

■ Selection of a site for a new headquarters building for the U.S. Atomic Energy Commission near Germantown, Md., 23 mi from Washington, and ½ mi west of the new U.S. Highway 240 on state Route 118, has been announced by Kenneth E. Fields, AEC general manager. The exact boundaries of the site will be determined after completion of detailed engineering surveys.

The major criteria used in making the selection included availability of an adequate water supply, extent of supporting community facilities, accessibility to Washington for business and commuting purposes, availability of a labor market, and factors affecting the economy of construction and operation.

At least 50 acres of land will be required for the $10 million project. Final design of the building has not been determined, but it probably will be a three-story reinforced concrete structure. Construction is scheduled to be completed in the fall of 1957.

■ Experimental cytologists have long wished to know whether any sort of change takes place in the nuclei of cells undergoing differentiation, change that would make such nuclei no longer equivalent to those of the fertilized egg cell and the very young embryo. To study this problem, two investigators have developed an ingenious series of techniques. By first separating layers of cells from differentiated tissues of frog embryos in the late gastrula stage by means of digestion with the enzyme trypsin, and then separating these cells with the detergent versene, T. J. King and R. Briggs of the Institute for Cancer Research and the Lankenau Hospital Research Institute in Philadelphia have gained a notable insight into the processes of animal development. [*Proc. Nat. Acad. Sci. U.S.* **41**, 321 (May 1955)].

Having isolated the specialized cells from such tisues as the chorda-mesoderm or the belly endoderm, the invesigators implant the nuclei singly into eggs from each of which the original nucleus has been removed. Such eggs seem to be able to develop quite normally through the blastula stage, a many-celled hollow sphere. When the implanted nuclei are taken out of the tissue cells of an early gastrula, these blastulae go on to develop normally into young larvae. When, on the other hand, the implanted nuclei come from older and more differentiated gastrulae, development is arrested, either in the blastula or gastrula stage, or somewhat later.

The nuclei that come from the endoderm of a late gastrula seem to be able to control the development of the internal parts well enough, but the ectodermal derivatives, including the presumptive skin and the nervous system, are grossly disorganized. Here, then, is evidence that in the course of development nuclei lose some of their original capacities and become specialized. How this takes place is still a mystery. Does it involve an actual modification of the genes and chromosomes themselves? Are certain genes put out of action, so to speak, because they stayed too long in the wrong sort of cellular environment?—B.G.

■ George R. Harrison, dean of the School of Science at Massachusetts Institute of Technology, is preparing a full-length biography of Karl T. Compton, long president of the institute and later chairman of its corporation, who died last year. This biography, which is being sponsored by M.I.T. and the McGraw-Hill Book Co., of which Dr. Compton was a director, is "official" in the sense that the Compton family is making Dr. Compton's letters and files available to Harrison.

Harrison plans the book not only as a presentation of the life of a very remarkable man whose influence on American science was extremely broad, but as an opportunity to discuss in layman's terms many of the problems faced today by the scientist, the teacher, the college administrator, and the conscientious and unselfish public servant. The book is expected to appear early in 1958.

Scientists in the News

Few scientists reach the age of 85 years and still fewer can boast of continued scientific productivity at that age. On 6 Apr. OSKAR VOGT, director of the Institute of the German Brain Research Society located at Neustadt in the Schwarzwald, passed that birthday with no indication of a relaxation of his scientific efforts. His wife, also a noted scientist and his collaborator for many years, had a few weeks earlier passed her 80th birthday.

Vogt, who founded the Kaiser-Wilhelm Institute for Brain Research (Hirnforschung) in Berlin-Buch, was dispossessed by the Nazis in 1937, after he had brought the institute from its humble beginning in 1902, as the Neurobiological Laboratory of the University of Berlin, to its later world-wide fame. Here Vogt not only founded the architectonic study of the brain but, with a breadth of vision possessed by few, insisted on the inclusion in the institute of many varied studies which might eventually, he hoped, contribute to a better understanding of the human brain.

Here, for example, Tönnies and Kornmüller began their studies of the relationships of the electric brain-waves to the architectonics of the cerebrum; here too Timoféeff-Ressovsky built up the fine department of genetics which was one of the foremost centers of German biology in the years before World War II. To the Institut für Hirnforschung came guests and students from all over the world, including the present writer, who worked there for 6 interesting months in 1934.

Beginning anew at the age of 67, Oskar Vogt built the laboratory in the Schwarzwald where he still labors. Since that age, when most men retire, he has contributed no less than 33 papers to his field, in 21 of which his wife collaborated, among them the significant report of the pathoanatomical findings in the brains of schizophrenics, which Vogt has interpreted as the premature aging of certain nerve-cell regions. These contributions cap a career that began with Vogt's first publication in 1895—a career that has always included interesting side excursions, such as the published studies of the geographic variation and evolution of the bumblebees of Europe. It is not surprising that, with parents such as Oskar and Cécile Vogt, both of their daughters have likewise become well-known scientists, Marthe in chemistry and pharmacology, Marguerite in genetics.

If few have labored so hard and so incessantly to advance human knowledge, far fewer have so fully earned the fond admiration and esteem of those who have worked with them.—B. G.

The following appointments to assistant professor have been announced: University of Oklahoma: IRENE MACKINTOSH, psychology. University of Oregon, HARRY EASTERDAY, physics.

On 1 Aug. CHESTER S. KEEFER resigned as special assistant to the Secretary of Health, Education, and Welfare, in order to be able to devote full attention to his duties as director of medical affairs at Boston University.

WILLIAM R. DURYEE of the National Cancer Institute has recently been appointed research professor of physiology at the George Washington University School of Medicine, Washington, D.C.

On 26 July CARL GUSTAV JUNG, famous pioneer in psychoanalysis, celebrated his 80th birthday in Zurich, Switzerland. Jung shares credit with the late Sigmund Freud and Alfred Adler for the early development of psychoanalysis.

Leading psychologists from many countries went to Zurich to honor Jung. Official receptions culminated in a dinner, and congratulatory messages flowed in from all over the world.

The author of many widely read books and essays, Jung still studies and writes. He also devotes much time to advising students at the Jung Institute.

The American Society for Testing Materials made the following awards during its 58th annual meeting in Atlantic City, N.J., 24 June–15 July:

Richard L. Templin award. M. SCOTT HUNTER and WILLIAM G. FRICKE, JR., of the Aluminum Research Laboratories, Aluminum Co. of America, New Kensington, Pa., for their paper "The metallographic aspects of fatigue behavior," which was presented at the 1954 annual meeting.

Sanford E. Thompson award. RICHARD C. MIELENZ, head of the Petrographic Laboratory, U.S. Bureau of Reclamation, Denver, Colo., for his paper "Petrographic examination of concrete aggregates."

C. A. Hogentogler award. HAROLD G. MASON and JOHN A. BISHOP, U.S. Naval Civil Engineering Research and Evaluation Laboratory, Port Hueneme, Calif., and PHILIP P. BROWN and L. A. PALMER of the Bureau of Yards and Docks, Department of the Navy, Washington, D.C., for their paper "Piles subjected to lateral thrust." Mason and Bishop received the award for Part 1 of the paper on "Measurement of earth pressure and deflection along the embedded portion of a 40-ft steel pile"; and Brown and Palmer for Part 2 on "Analysis of pressure deflection, moment, and shear by the method of difference equations."

Max Hecht award. EVERETT P. PARTRIDGE, director of the Hall Laboratories, Inc., Pittsburgh, Pa., for outstanding service to ASTM Committee D-19 on Industrial Water in the advancement of its objective—the study of water as an engineering material.

Three scientists of the Canadian National Research Council have been named fellows of the Royal Society of Canada: N. E. GIBBONS, head of the food microbiology section, Division of Applied Biology; J. A. MORRISON, head of the surface chemistry section, Division of Pure Chemistry; and E. PICKUP of the cosmic ray group, Division of Pure Physics.

HENRY B. STRENGE, a faculty member of the University of Oklahoma School of Medicine since 1947, became the first full-time head of the department of pediatrics on 1 July. He succeeds CLARK H. HALL, a practicing pediatrician, who will continue as professor of pediatrics.

On 1 Aug. ROBERT F. A. STUDDS, rear admiral, retired as director of the U.S. Coast and Geodetic Survey.

RUGGLES GATES, of Cambridge, Mass., will sail for South Africa on 19 Aug. He has received a grant from the Wenner-Gren Foundation for a study of Hottentot origins and for investigation of Australopithecine material. He will lecture at various universities, including Capetown, and he will look for pygmy hybrids in Uganda and for other race crosses in Kenya. Gates will be accompanied by his wife, who will make color photo records. The couple expect to return in December by way of Sudan and Egypt.

C. KNIGHT ALDRICH, associate professor of psychiatry in the University of Minnesota Medical School, has been appointed professor of psychiatry and chairman of the department at the University of Chicago School of Medicine. His chief fields of interest are teaching, both of medical students who are training to become psychiatrists and of those who will specialize in other branches of medicine, and in furthering integration of psychiatry with other medical specialties.

HERBERT P. RILEY, head of the department of botany of the University of Kentucky, is leaving soon to serve until next June as a Fulbright professor in the department of genetics, University of Pretoria, Pretoria, Union of South Africa. During his absence, C. E. HENRICKSON will be acting head of the department of botany.

HAROLD LYONS, physicist, has joined the senior technical staff of the Microwave Laboratory, Hughes Aircraft Co., Culver City, Calif., where he will work on atomic, molecular-frequency, and time-control amplifiers. He joins Hughes with a background in nuclear, atomic, and microwave physics acquired at the National Bureau of Standards, the U.S. Naval Research Laboratory, and the University of Michigan.

Two General Electric Co. scientists previously associated with other laboratories in the company have been appointed to the staff of the G.E. Research Laboratory at The Knolls. CECIL G. DUNN has been a physical metallurgist with the company at Pittsfield, Mass., since 1937, and PAUL D. GORSUCH has been a metallurgical engineer at the materials and processes laboratory in Schenectady since 1945. Both men will now serve as research associates in the metallurgy and ceramics department of the Research Laboratory.

LEONARD BROADBENT, entomologist and plant pathologist at the Rothamsted Experimental Station in England, is conducting research at the Connecticut Agricultural Experiment Station, New Haven, Conn. Broadbent, who is an authority on transmission of virus diseases by insects, expects to visit this country for approximately 3½ mo.

DOHRMANN K. PISCHEL, clinical professor of surgery at Stanford School of Medicine, is the new executive head of the division of ophthalmology in the department of surgery. He succeeds A. EDWARD MAUMENEE, who has been appointed head of the eye department at Johns Hopkins Medical School.

FREDERIC W. RHINELANDER, assistant clinical professor of orthopedic surgery in the University of California School of Medicine, San Francisco, has been appointed associate professor of orthopedic surgery at Western Research University School of Medicine. He also will be chief of the orthopedic service at City Hospital, Cleveland, Ohio.

JOHN POWELL, formerly associate professor of physics at the University of Wisconsin, and more recently director of the theoretical physics section of the Missile Systems Division of Lockheed Aircraft Corp., has been appointed associate professor of physics at the University of Oregon.

JOHN MARKLE, professor of botany at Texas A. & M. College, has been granted a leave of absence for the current academic year. He will be visiting professor of botany in the department of biological sciences at Purdue University, where he will conduct research in collaboration with A. A. LINDSEY on the ecology of floodplains.

JULIAN ROFFMAN of Toronto's Meridian Productions has won the 1955 Blakeslee award for producing the C.B.S. Television motion-picture *Gate 27*. Charles O'Neill was the author of the play, which was a dramatization of the achievements of research on heart disease.

ROBERT S. HATCHER, former assistant chief of the U.S. Navy Bureau of Aeronautics in charge of research and development, has been appointed director of the Guggenheim School of Aeronautics, New York University College of Engineering. He also was named chairman of the department of aeronautical engineering, with the rank of professor.

He succeeds FREDERICK K. TEICHMANN, who has headed the Guggenheim School since 1945. Teichmann will devote full time to his duties as assistant dean in charge of the day division of the College of Engineering.

PHILIP L. KURTZ, practicing physician and assistant professor of medicine at Indiana University, has joined the research laboratories of Eli Lilly and Co., Indianapolis, Ind. He has been named editor of *De Re Medica*, Lilly reference book on therapeutics and pharmacology that is undergoing revision; in addition, while S. O. WAIFE is in military service, Kurtz will act as editor of the *Physician's Bulletin*, the company's monthly publication.

ROBERT G. PICARD, until recently manager of scientific instruments engineering for the Radio Corporation of America, has joined Central Scientific Co., Chicago, Ill., as director of research and engineering development. He replaces HARRIS M. SULLIVAN, who recently became associated with the General Electric Co. Picard has spent the past 12 years in the development of scientific instruments in the fields of chemistry, physics, biology, and metallurgy.

J. CHESTER BRADLEY, professor emeritus of the Cornell entomology department and a founder of the Entomological Society of America, has been elected an honorary fellow of the Royal Entomological Society of London. Only 11 Americans have been thus cited in the last 120 years. Outside of Great Britain, only 75 persons have ever been elected. In addition to Bradley, the only other living American so honored is R. E. SNODGRASS, Smithsonian Institution, Washington, D.C.

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The American Cancer Society's Bronze Medal for "important contributions to the control of cancer for 1954" has been awarded to FRED W. STEWART, chief of the department of pathology at the Memorial Center for Cancer and Allied Diseases, New York.

JERROLD R. ZACHARIAS, director of the laboratory for nuclear sciences and engineering of the Massachusetts Institute of Technology, has been presented the Certificate of Appreciation, the Defense Department's highest civilian honor. The citation stated that Zacharias, "by serving as director of a series of military-scientific study projects of great national significance, has rendered exceptionally distinguished service and has given major impetus to the scientific progress of the United States Navy and Air Force."

ALFRED B. FOCKE, physicist, has been named director of the Marine Physical Laboratory of the University of California's Scripps Institution of Oceanography. He succeeds CHARLES S. WRIGHT, who has retired. Focke has been a member of the Scripps staff since 1954, before which he was associate technical director of research for the U.S. Navy Electronics Laboratory.

R. J. POOL, emeritus professor of botany at the University of Nebraska, will serve as visiting professor of botany at Southern Illinois University during the coming academic year. Pool was an active member of the Nebraska faculty for 42 years, and for 33 of those years he was chairman of the botany department.

MARTIN M. WINBURY, formerly of G. D. Searle and Co., Chicago, Ill., has been appointed senior pharmacologist in the pharmacology research department of Schering Corp., Bloomfield, N.J.

Necrology

ARTHUR VON KROGH ANDERSON, State College, Pa., 65, professor emeritus of physiological chemistry at Pennsylvania State University, 8 July.

EDWARD P. CARTER, Bronxville, N.Y., 85, retired associate professor of medicine at Johns Hopkins University, 31 July.

ISAAC M. CLINE, New Orleans, La., 94, meteorologist and author, retired head of the New Orleans Weather Bureau, 3 Aug.

PETER J. DULLIGAN, SR., Brooklyn, N.Y., 71, former senior surgeon of St. Mary's Hospital, Brooklyn, 29 July.

FREDERICK D. HERBERT, Upper Montclair, N.J., 81, retired president and director of the Kearfott Co., Inc., makers of airplane instruments and electromechanical components, 4 Aug.

SOLOMON R. KAGAN, Boston, Mass., retired physician and author, 29 July.

JOHN I. MEAGHER, Washington, D.C., 65, retired colonel, U.S. Army Medical Corps, assistant medical director at the University of Maryland, 1 Aug.

ARNE MØLLER, Copenhagen, Denmark, librarian of the Danish Technical University, president of the International Federation for Documentation, 27 June.

DANIEL P. MOWRY, Montreal, Canada, 61, dean of the faculty of dentistry at McGill University, 2 Aug.

ARVID E. ROACH, Detroit, Mich., 35, supervisor of bearing development for the General Motors Research Laboratories, 28 July.

GEORGE H. ROUNDS, Yarmouth, Me., 79, retired professor of psychology at Columbia University, author, 29 July.

FRANCIS J. STOKES, Philadelphia, Pa., 81, founder and chairman of the board of the F. J. Stokes Machine Co., 1 Aug.

PAUL L. TARRARA, Rochester, Minn., 67, retired head of the Mayo Clinic chiropody department and president emeritus of the American Association of Hospital Chiropodists, 28 July.

SAMUEL WEISS, Washington, D.C., executive director of the American Statistical Association, 23 July.

NORMAN C. YARIAN, Cleveland, Ohio, 84, former chief of staff at Lutheran Hospital and instructor at Ohio Wesleyan University and Western Reserve University Medical School, 28 July.

LLOYD N. YEPSEN, New Lisbon, N.J., 58, psychologist and superintendent of the New Lisbon State Colony for the Feeble-minded, 1 Aug.

Education

■ A new degree, doctor of science in veterinary medicine, has been established at Cornell University. The D.Sc. in V.M. will be a professional degree for advanced study in such clinical practices as medicine, surgery, and therapeutics. The program was set up because it is felt that specialization in veterinary medicine has reached a point where the traditional Ph.D. program no longer suffices for all the various types of advanced training that are needed.

A new division of veterinary medicine in the Cornell Graduate School will administer the program. Applicants for admission must have graduated from an approved school of veterinary medicine at least 5 years previously and must have published papers demonstrating their ability in independent research.

Candidates with no graduate credit beyond their D.V.M. degree must complete at least 2 years of full-time study for the doctor's degree, and candidates with a master-of-science degree must complete at least 1 year.

■ The U.S. Public Health Service's Venereal Disease Program has announced that nine laboratory refresher courses covering the serology of syphilis, management and control of syphilis serology by the regional laboratory, and tests for syphilis using the *Treponema pallidum* will be offered at the Venereal Disease Research Laboratory in Chamblee, Ga., from Sept. 1955 through May 1956.

Applications for any of the courses must be signed by the state health officer

or state laboratory director unless the applicant is an employee of the Public Health Service. In such instances, application must be approved by the medical officer-in-charge. Correspondence about these courses should be addressed to: Director, Venereal Disease Research Laboratory, Division of Special Health Services, PHS, Department of Health, Education, and Welfare, P.O. Box 185, Chamblee, Ga.

■ The *Handbook For Teaching Conservation and Resource-use*, a 450-page book just completed by the National Association of Biology Teachers, describes the best means of helping children understand the importance of natural resources. The publication was prepared by 200 teachers from 30 states. The how-to-do-it stories and 82 illustrations will be helpful to other teachers and youth leaders.

The material for the *Handbook* was collected by the NABT National Conservation Committee. Since its initiation in 1951, the project has been directed by Richard L. Weaver of the School of Natural Resources, University of Michigan. The work was financed by a grant from the American Nature Association.

The volume may be obtained from Dr. Weaver, Box 2073, Ann Arbor, Mich. The cost is $4 per copy, but schools will be allowed a 20-percent discount. The proceeds will be used by the committee to continue its conservation education activities in the various states.

■ The Michigan State Board of Agriculture has announced that, by action of the Legislature, the name of Michigan State College of Agriculture and Applied Science has been changed to Michigan State University of Agriculture and Applied Science.

■ An appeal to the Nation's publishers to help stimulate interest in high-school mathematics and science courses has been made by the president of the National Society of Professional Engineers. In a letter addressed to approximately 800 publishers of daily newspapers, Allison C. Neff, of Middletown, Ohio, newly installed president of the 36,000-member engineering group, asked the help of the press as a first step to "stem the tide of students away from elementary mathematics, physics and chemistry."

Neff, vice president of Armco Drainage and Metal Products, Inc., asked publishers to consider these facts: (i) only about 25 percent of our high-school students now study algebra; (ii) only about 12 percent of our high-school students now study geometry; (iii) there are many small, and even some large, high schools that offer no courses in the physical sciences.

■ A special radiation biology course, one of the few offered in the United States, is being given for the second summer at the Duke University Marine Laboratory, Beaufort, N.C. The 6-wk course, which commenced 26 July, centers around study of how radiation affects living creatures. It provides background information and instruction in laboratory procedures for persons interested in radiation and radioisotope studies.

The biology division of the Oak Ridge National Laboratory is again cooperating with Duke in presenting the course. Five Oak Ridge scientists are visiting lecturers: Norman G. Anderson, physiologist; Alan D. Conger, cytologist; J. R. Totter, biochemist; Charles W. Sheppard, physicist; and A. C. Upton, pathologist.

The course includes laboratory study of the effects of radiation on both sperm eggs and cell division of marine organisms, as well as its effects on mammals, animal tumors, and plant chromosomes. A cobalt radiation source supplied by the Oak Ridge Laboratory is the principal tool.

■ The University of Chicago has approved two new courses leading to the M.S. degree in radiological physics and in health physics. Both degrees will be awarded by the department of radiology, and students will be accepted in the fall quarter. Students entering these courses should have completed the equivalent of the University of Chicago B.S. degree in physics; they must, in any case, complete all of the requirements for the master's degree.

Two years' residence is required because of the broad scope of the academic program, the second year of which is spent one-half time in academic work and one-half time in service in the department at a nominal rate of pay. Two years of course work give the student a strong background in physiology, biochemistry, biophysics, anatomy, toxicology, and radiological physics. Additional information may be obtained from Lester S. Skaggs, Department of Radiology, University of Chicago, 950 E. 59 St., Chicago 37, Ill.

Grants, Fellowships, and Awards

■ In addition to inviting Fulbright award applications [*Science* **122**, 117 (15 July 1955)], the Committee on International Exchange of Persons of the Conference Board of Associated Research Councils has announced the availability of awards for lecturing abroad under the Smith-Mundt Act. In 1956–57 a limited number of grants will be provided for lecturing in about 30 countries, including, according to present plans, Brazil, Chile, China (Taiwan), Colombia, Costa Rica, Cuba, Ecuador, Egypt, Guatemala, Haiti, Iceland, Indo-China, Iran, Israel, Korea, Lebanon, Mexico, Pakistan, Panama, Paraguay, Peru, Portugal, Spain, Switzerland, Syria, Turkey, Uruguay, and Venezuela.

Universities and colleges in these countries are expected to request American lecturers for the academic year, or occasionally for shorter periods, in a wide variety of fields. On the basis of past experience, the committee expects the science requests to be concentrated in agriculture, anthropology, chemistry, engineering, geology, mathematics, physical education, physics, psychology, and sociology.

Foreign universities usually communicate their needs to the Conference Board committee at intervals throughout the year, generally a year in advance, but in some cases only 2 to 3 mo before the starting dates of the lectureships. Under these circumstances, the committee believes it advisable not to issue program announcements and invite applications, but, instead, to ask interested professors to register with the committee. The register will be consulted for qualified candidates for lectureships under the Smith-Mundt Act, and also for lectureships that remain unfilled in the exchange program under the Fulbright Act after the review of applications submitted in the open competition.

Persons wishing to register must be citizens of the United States. In general they will be expected to have had at least 1 year of college or university teaching experience in the United States or abroad. The committee invites correspondence from professors interested in lecturing abroad, either in the immediate or indeterminate future. For information write the Conference Board of Associated Research Councils, Committee on International Exchange of Persons, 2101 Constitution Ave., Washington 25, D.C.

■ The Arthritis and Rheumatism Foundation is offering the following fellowships for research in the basic sciences related to arthritis: (i) predoctoral fellowships ranging from $1500 to $3000 per annum, depending on the family responsibilities of the fellow, tenable for 1 year with prospect of renewal; (ii) postdoctoral fellowships ranging from $4000 to $6000 per annum, depending on family responsibilities, tenable for 1 year with prospect of renewal; (iii) senior fellowships for more experienced investigators that will carry an award of $6000 to $7500 per annum and are tenable for 5 years.

The deadline for applications is 15 Oct. For information, address the Medical Director, Arthritis and Rheumatism Foundation, 23 W. 45 St., New York 36.

■ Acting for the American Cancer Society, the Committee on Growth of the National Academy of Sciences–Research Council is accepting applications for grants-in-aid for cancer research in the United States. Applications received *before 1 Oct.* will be considered during the winter; grants that are recommended will become effective on 1 July 1956. Investigators now receiving support will be notified regarding application for renewal.

The committee feels that an understanding of cancer depends upon a deeper insight into the nature of the growth process, normal and malignant. Therefore, the scope of the research program is broad and includes, in addition to clinical investigations on cancer, fundamental studies in the fields of cellular physiology, morphogenesis, genetics, virology, biochemistry, metabolism, nutrition, cytochemistry, physics, radiobiology, chemotherapy, endocrinology, and carcinogenesis. The committee is particularly interested in encouraging research in the epidemiology of cancer. Application blanks may be obtained from the Executive Secretary, Committee on Growth, National Research Council, 2101 Constitution Ave. NW, Washington 25, D.C.

In the Laboratories

■ A comprehensive program of scientific research designed to develop improved processing methods and to create new uses for cattle hides has been launched by the American Meat Institute Foundation, Chicago, Ill. Financing, which has been arranged at the rate of $25,000 per year for a 3-year period, has been underwritten through special contributions by beef processing establishments located in all parts of the United States. The new research program has been established to combat the increasingly serious loss of markets for hides and skins to competitive products.

■ The Ramo-Wooldridge Corp., Los Angeles, Calif., has announced the establishment of a new division, the Aeronautics Research Laboratory, that will be devoted to advanced studies and projects in aerodynamics and related fields. Milton U. Clauser is to be director of the laboratory, but he will continue his duties in the company's guided missile research division.

■ On 29 July Chas. E. Oakes, president of Pennsylvania Power and Light Co., informed the Atomic Energy Commission of the company's decision to build a privately financed atomic-electric power plant of at least 150,000 kw. The plant will utilize a homogeneous-type reactor, on the basis that such a plant will be commercially competitive with generating stations using conventional fuels. The new facility is expected to be operating by 1962.

A contract has been entered into with Westinghouse Electric Corp. as codeveloper with PP&L in the design and as supplier for the reactor and its related electric generating equipment. The joint program will be known as the Pennsylvania Advanced Reactor Project (PAR Project).

■ Chemsearch, New Rochelle, N.Y., a new mail service for supplying information about sources of organic chemicals, has been organized by L. E. Mackay and E. A. Falco, formerly of Wellcome Research Laboratories.

Miscellaneous

■ *Biological Abstracts* has announced publication of *Biological Sciences, Serial Publications, a World List 1950–1954.* This is the fourth bibliography compiled by the Science Division of the Library of Congress. The titles of these publications, which are designed to keep scientists informed of the world literature in their field, are (i) *Scientific and Technical Serial Publications, United States 1950–1953*; (ii) *Scientific and Technical Serial Publications, Soviet Union 1945–1953*; and (iii) *Chinese Scientific and Technical Serial Publications in the Collections of the Library of Congress.* All but the Chinese bibliography, which was a separate Science Division project, have been sponsored by the National Science Foundation. Unlike the earlier works, which deal with publications from the various scientific disciplines on a geographic basis, the present volume is prepared on a subject basis: it includes biological serials, wherever published.

The period covered by this compilation begins with Jan. 1950 and ends with Dec. 1954, except where more recent bibliographic information has made possible the inclusion of a few 1955 titles. The text consists of about 3500 titles, grouped under the broad headings of general biology; botany; zoology; science of man; and general science. (The last category contains serials that contribute significant numbers of biological papers.)

Except in those rare instances when a serial was not available for examination, under each title is listed the issuing agency and/or publisher; the city and country of publication; the date of first issue; and the frequency of most recent issues. Bibliographic notes include (i) description of publications whose nature is not revealed by title or frequency (i.e., monographic series, collected reprints); (ii) language of text or summaries, or both, when they differ from the title; and (iii) data such as title changes, mergers, or any interruption of publication. Lastly, the contents, or types of material making up the regular features of a publication, are described briefly.

Following the text is what is believed to be a very useful feature, an "Index of Titles, Societies and Institutions," arranged by country of origin and publication. This index is coded to indicate, also, those serials that appear in the May 1955 list of publications serving as source material for *Biological Abstracts.* The volume concludes with a subject index.

Biological Abstracts is so deeply convinced of the need of biologists and of all those concerned with the literature of biology for a world list of biological serials that it has undertaken the publication and distribution of this work. At a cost of $2 each, copies may be obtained from *Biological Abstracts,* University of Pennsylvania, 3815 Walnut St., Philadelphia 4, Pa.

■ The estimates of requirements for rhesus monkeys for medical and biological purposes, submitted in response to the Public Health Service survey of needs, was completed on 5 June 1955. Further action has been delayed pending negotiations by the State Department with the Government of India. It is now reported that the United States Mission to India and the United States Embassy in India have secured the agreement of the Government of India to permit exportation of rhesus monkeys for the period ending 30 June 1956, under certain conditions.

All needs must be certified by the United States Government through the Public Health Service. Information concerning Public Health Service procedure and Certificate of Need forms may be secured from National Institutes of Health, Room 1012, Building T-6, Bethesda 14, Md.

■ On 1 July the Bureau of Ordnance, Department of the Navy, Washington 25, D.C., published an 88-page list of current vacancies in the bureau and in its field stations. Many of the employment opportunities described are for engineers, physicists, and mathematicians.

■ A 500-volume ecology and entomology library owned by the late G. M. Bentley has just been purchased by the Oak Ridge National Laboratory Libraries Division for use in the Health Physics Division library. Bentley, state entomologist and plant pathologist, was professor of entomology at the University of Tennessee before his death last year. The library also contains some 1600 reprints that were the collection of E. A. Popenoe, one of the country's earliest teachers of entomology.

Reports and Letters

Cis-aconitic Decarboxylase

Isotopic tracer studies have shown that the biosynthesis of itaconic acid in fungi is closely related to tricarboxylic acid cycle reactions (*1, 2*) probably proceeding through decarboxylation of *cis*-aconitic acid (*3*). Previously, Calam, Oxford, and Raistrick had ruled out this possibility because of negligible conversion of citric acid to itaconic acid in replacement experiments (*4*). Furthermore, it has not been possible to demonstrate the presence of citric or *cis*-aconitic acids in culture filtrates of *Aspergillus terreus* (*2*).

Direct evidence for a role of *cis*-aconitic acid in itaconic acid biosynthesis has now been obtained with preparations of a soluble enzyme, *cis*-aconitic acid decarboxylase (*5*). These preparations, which are most active over the range *p*H 5.6 to 5.9, readily decarboxylate *cis*-aconitic acid but not *trans*-aconitic acid, forming stoichiometric amounts of itaconic acid and carbon dioxide. *Trans*-aconitic acid is not a competitive inhibitor. *Cis*-aconitic decarboxylase is a rather unstable enzyme in the present preparations, losing about half of its activity during overnight storage at 0°C. The enzyme is almost fully active after dialysis for 2 hr at 0°C against 0.05*M* phosphate buffer, *p*H 7, but it is completely inactive if this dialysis is continued overnight. The activity of such preparations is not restored by the addition of boiled preparations or by other possible cofactor sources (yeast extract, Mg^{++}, Mn^{++}, and pyridoxal phosphate).

Table 1. Results of a typical experiment. Each flask contained 1 ml of enzyme preparation, 1.6 ml of 0.2*M* phosphate buffer (*p*H 5.6), with *cis*-aconitic acid added as a neutral sodium salt from side arms. The reaction was carried out for 90 min.

Cis-aconitic acid initially* (μ*M*)	Carbon dioxide evolved (μ*M*)	Itaconic acid produced† (μ*M*)	Aconitic acid recovered‡ (μ*M*)
6.6	5.3	5.4	Not determined
13.2	9.8	10.7	1.1

* Calculated from weight of *cis*-aconitic anhydride used.
† These values have been corrected for the itaconic acid originally present in the enzyme preparation.
‡ Mainly as the *trans* form.

The enzyme preparations are obtained from surface cultures of *A. terreus* grown at 28°C on 100-ml portions of the medium described by Lockwood and Ward (*6*). The mycelial pad covers the surface 4 to 5 days after inoculation, at which time the culture medium contains between 7 and 15 mg of itaconic acid per milliliter. The original culture medium is replaced with distilled water (100 ml), and the mycelium is allowed to stand on this water for 1 hr at room temperature. All subsequent operations are carried out in the cold room. The mycelium, which in a typical case has a wet weight of 2.3 g and a dry weight of 0.6 g, is washed with several portions of ice cold water and is then ground in a mortar with 3 ml of 0.2*M* phosphate buffer, *p*H 6.5, in the presence of about 1.5 g of glass beads (*7*). The paste is diluted with more phosphate buffer (7 ml) and centrifuged at 1500 g for 20 min at 0°C. The supernatant is passed through a filter paper, yielding an opalescent solution with a slight orange-tan color. Such solutions have *p*H values between 6.5 and 6.7 and contain some itaconic acid that is released from the cells during the grinding process. The protein content is between 2.5 and 3.0 mg/ml. Similar preparations of the enzyme have been obtained from the vegetative mycelium that is obtained in shake cultures; in these cases, the mycelium is separated and washed by centrifugation prior to grinding.

The decarboxylation reaction is followed manometrically at 37°C. After the reaction is completed, deproteinization is carried out with alcohol, and the organic acids present are separated by partition chromatography on Celite columns (*8*). Solvents are evaporated from the appropriate pooled fractions and the residues are analyzed for aconitic and itaconic acids by a modification of the method of Dickman (*9*). The results in a typical experiment are shown in Table 1.

This appears to be the first description of an enzyme that can bring about the decarboxylation of an α,β-unsaturated acid, producing the methylene group. Similar enzymes may play a role in the biosynthesis of other naturally occurring compounds that contain this group (for example, alliin, penicillic acid, allyl phosphate, and more complex compounds in the terpene series). In particular, it seems possible that the biosynthesis of the recently discovered γ-methylene-α-ketoglutaric acid (*10*) and of the related γ-methylene glutamic acid and γ-methylene glutamine (*11*) may be closely related to that of itaconic acid. It is suggested that the γ-methylene-α-ketoglutaric acid is obtained by the action of a specific decarboxylase on 4-oxo - 1-butene - 1,2,4-tricarboxylic acid. The most likely precursor for this unsaturated acid appears to be 2-hydroxy-4 - oxo - 1,2,4 - butanetricarboxylic acid (oxalocitramalic acid); since this is not a metabolic intermediate (*12*), the closely related 4-phosphate of 2,4-dihydroxy - 1,2,4 - butanetricarboxylic acid may be the actual C_7 compound involved. This phosphate is known to be present in dog liver (*13*,) and has been identified as an intermediate in bacterial metabolism (*14*).

RONALD BENTLEY
CLARA P. THIESSEN
Department of Biochemistry and Nutrition, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pennsylvania.

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6 May 1955

Copper in Hair

In a recent paper on the nature of pigments derived from tyrosine and tryptophan in animals (*1*), Kikkawa, Ogita, and Fujito have proposed the idea that color of hair is in some way related to its content of iron, cobalt, nickel, molybdenum, and copper.

Loss of coat color in cattle grazing on pastures high in molybdenum content has been observed in England (*2*) and in California (*3*), and it is now well-known that the feeding of small amounts of copper sulfate to affected animals restores the color to new growth of hair. It has also been shown by Goss (*4*) that the wool of black sheep that are fed an excess of molybdenum as sodium molybdate grows out colorless, but the black pigment quickly reappears when 100 parts of copper per million are added to the high molybdenum ration.

Analyses of the black wool for copper showed 17 ppm, whereas the grey portion of the same fibers after molybdenum-feeding contained only 13 ppm. However, white wool from normal sheep consistently showed more copper than black, contrary to the report of Kikkawa *et al.* for the guinea pig, rabbit, and man. We therefore collected samples of light and dark shades of hair from a number of species and determined the copper content. The values are given in Table 1, together with the corresponding figure from the paper by Kikkawa *et al.* (*1*), recalculated in parts per million. Apparently their results were obtained by spectroscopic analyses of the ash obtained by combustion of the hair in a furnace at 600°C. Our results were obtained on thoroughly washed and dried hair by a "wet-ashing" method using sulfuric, perchloric, and nitric acids; the copper was estimated colorimetrically in duplicate by use of the diethyldithiocarbamate method described by Clare *et al.* (*5*). Except in the hog, we have found as much, if not more, copper in white or light-colored hair than we have found in black hair of the same species.

Table 1. Copper content of hair in parts per million of washed, dry hair.

Source	This report	Kikkawa *et al.*
Cat, black	14	
Cat, white	34	
Holstein cow, black area	12	
Holstein cow, white area	13	
Hereford cow, dark red	27	
Hereford cow, light red	30	
Hereford cow, light red	26	
Hereford calf, red area	17	
Hereford calf, white area	23	
Angus bull, red	15	
Dog, black	17	
Dog, white	25	
Guinea pig, black	11	8
Guinea pig, golden	13	5.2
Guinea pig, white (albino)	15	2.3
Hog, black	17	
Hog, white	12	
Horse, black	10	
Horse, white	15	
Man, Caucasian,		
3-yr-old child, red	47	
Same, as adult	15	
Adult, red	18	
Mexican child, red	18	
Man, Mongolian, black	15	19
Man, Negroid	15	31
Rabbit, black	14	3
Rabbit, white (albino)	17	Trace
Rabbit, white (albino)	20	
Rabbit, white (albino)	19	
Rat, black	14	
Rat, white (albino)	14	
Sheep, black	17	
Sheep, black, high Mo feed	13	
Sheep, white	20	

As far as the copper content of hair is concerned, our results do not agree with those reported by the Japanese authors, and we find no confirmation of the statements that black hair is associated with a high copper content, and that white hair is low in copper or contains only a trace of copper.

HAROLD GOSS
M. M. GREEN
Departments of Animal Husbandry and Genetics, University of California, Davis

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18 April 1955

Enhancement of Radiobiological Effect by Malonic and Maleic Acids

Certain biological actions of radiations are generally believed to involve chemical intermediates, mostly formed from irradiated water, and in some of these actions the intermediates are believed to be peroxides (*1*). These substances may attack various important reaction systems in the cell at various sites, for example, sulfhydryl and other reactive groups, especially in sulfhydryl enzymes (*2*).

In many of our experiments, in which cell death was the criterion of effect, we failed to enhance the radiation effect by inhibiting oxidative phosphorylation, which has recently been reported to be exceptionally sensitive to irradiation (*3*). These negative results may be due to masking effects or to recovery of the system. Only with malonic and maleic acids were positive results obtained. Malonic acid inhibits oxidative phosphorylation and is highly specific as a competitive inhibitor of succinic dehydrogenase. Maleic acid, although not so specific for succinic dehydrogenase, is a universal inhibitor of sulfhydryl enzymes.

Saccharomyces ellipsoideus, the experimental material, was cultured in Nägeli's solution for many generations. After x-irradiation (60 kv, 1000 r/min), the cells were cultured on Nägeli agar at *p*H 7. Photographs were taken and microscopic counts were made at intervals for some 20 hr. Single cells and also pairs of enlarged cells, which are ascribed to death after one division, were scored as nonsurvivors; the counts of these categories do not change in the course of prolonged incubation. Five to 10 cultures were counted in each experiment, and every culture contained 400 to 500 cells.

Malonic acid in concentration $10^{-3}M$ without irradiation produced no detectable injury. Its sensitizing action, when it was added to the Nägeli culture solution before irradiation, is demonstrated by the data in Table 1.

If fumaric or aspartic acid was added to the Nägeli agar on which the cells were cultured after irradiation, the results shown in Table 2 were obtained. It appears that the effect of each of these acids on cells pretreated with malonic acid is essentially to bring the survival back to the value obtained when malonic

Table 1. Sensitization by malonic acid applied before irradiation.

X-ray dose (r)	Percentage survival (calibrated by control)	
	Malonic acid, $10^{-3}M$	No malonic acid
0	100 ± 1.3	100 ± 1.1
10,000	45.1 ± 3.2	77.5 ± 6.5
20,000	32.8 ± 2.1	47.9 ± 3.2
30,000	17.8 ± 2.4	30.0 ± 1.2
50,000	8.6 ± 0.9	10.6 ± 0.4

Table 2. Recovery owing to fumaric and aspartic acids after 20,000 r of x-rays (calibrated by nonirradiated cells).

Treatment before irradiation	Treatment soon after irradiation	Survival (%)
None	None	48.0 ± 2.4
Malonic acid, $10^{-3}M$	Fumaric acid, $2 \times 10^{-3}M$	50.0 ± 1.1
None	Fumaric acid, $2 \times 10^{-3}M$	50.0 ± 1.3
Malonic acid, $10^{-3}M$	Aspartic acid, $10^{-3}M$	51.8 ± 2.8
None	Aspartic acid, $10^{-3}M$	51.8 ± 1.9

Table 3. Recovery owing to cysteine after 20,000 r of x-rays (calibrated by non-irradiated cells).

Treatment before irradiation	Treatment after irradiation	Survival (%)
Malonic acid, $10^{-3}M$	Cysteine, $10^{-3}M$	67.2 ± 2.4
None	Cysteine, $10^{-3}M$	72.1 ± 2.6

Table 4. Sensitization by maleic acid applied before 20,000 r of x-rays (2000 cells were counted as a whole, and calibration was held by control).

Molar concn. of maleic acid in Nägeli's soln.	Survival (%)	
	Irradiated	Non-irradiated
10^{-3}	22.6	85.3
10^{-4}	36.1	96.2
10^{-5}	43.4	102.1
0	47.1	100

acid was not used (compare Table 2 with third line of Table 1). This may be explained on the hypothesis that fumaric or aspartic acid removes the block produced in the tricarboxylic acid cycle by malonic acid.

In other experiments, cysteine was added to the Nägeli agar to reactivate altered sulfhydryl groups in the irradiated cells (Table 3). Although there was a substantial recovery owing to cysteine (compare Table 1 with Table 3), the sensitizing action of malonic acid was not completely overcome by the cysteine; there was the statistical significance of the difference between 67.2 and 72.1 percent.

The effect of maleic acid on radiosensitivity is shown by the data in Table 4. This acid, in concentrations less than $10^{-3}M$, has no inhibiting influence on growth of the yeast cell but seems to sensitize the cell to radiation, the effect varying directly with concentration in the culture medium. However, its concentration and distribution in the cell are unknown.

M. Kiga
Y. Ando
H. Koike

Department of Radiology,
Showa Medical School, Tokyo, Japan

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28 March 1955

Tests of a Soil Sterilant for Forestry Use

The chemical compound 3-(*P*-chlorophenyl)-1,1-dimethylurea (CMU) (*1*) has been tested in the sand hills of western Florida to determine whether it would kill scrub oaks and wire grass and permit reforestation with planted pines. CMU (*2*) is a nonvolatile, slightly acid, grayish-white powder with a very low solubility in water (230 ppm). It has relatively low flammability and mammalian toxicity.

The chemical was applied to the soil as an aqueous suspension in 10 dosages from 0 to 37 lb/acre in March 1953, each treatment being replicated four times. Mortality of woody plants was determined by actual stem count, while ground cover was surveyed by line-spot transects. The results are based on differences between pretreatment and post-treatment vegetation surveys.

A vegetation survey that was made 16 mo after application showed that dosages of 11 lb or more per acre had controlled scrub oaks of all sizes. Twenty-two pounds or more was necessary to control grass and other ground cover. Necrosis first appeared around the leaf margins of oaks and on the tips of pines and grasses. Oaks (*Quercus laevis* and *Q. incana*) that received dosages of 22 lb or more lost as many as three sets of leaves during the first growing season after treatment. Wire grass (*Aristida stricta*), the pretreatment dominant, was nearly eradicated at dosages around 7 lb/acre, but it was replaced by *Sorghastrum nutans*, *Panicum virgatum*, *Andropogon scoparius*, and *Andropogon floridanus* during the second growing season after treatment (Table 1). Ingressive grasses in treated plots were much taller and more vigorous than those in untreated border strips. Weed species that were the most resistant to CMU included cactus (*Opuntia* spp.), saw-palmetto (*Serenoa repens*), sassafras (*Sassafras albidum*), and yucca (*Yucca* spp.).

Table 1. Mortality of oaks and ground cover at end of second growing season after application of CMU to the soil.

Dosage (lb/acre)	Mortality (%)			
	Oaks 8 ft and taller	Oaks 4–8 ft tall	Oaks 1–4 ft tall	Ground cover
0	0	19	13	5
1	26	0	0	31
2	23	12	19	11
4	57	20	4	14
7	87	84	13	14
11	98	99	97	3
16	100	100	99	43
22	100	100	99	74
29	100	100	100	86
37	100	94	97	79

Forty-nine slash pines (*Pinus elliottii* Engelm.) were planted in each plot in January 1954, 9 mo after application of the chemical. Analyses of soil samples for residual CMU were made in July 1954. Phytotoxic amounts were found even in soil that had received dosages of 4 lb/acre; pine survival counts made in September 1954 revealed that 24 percent of the trees in this treatment were dead or severely chlorotic. Pines in the 37-lb treatment suffered 98-percent mortality and injury. The persistence of CMU even at low dosages makes its value for use in forestry questionable.

Frank W. Woods*
Southern Forest Experiment Station, Forest Service, U.S. Department of Agriculture

Notes

1. It is also known as Karmex W.
2. E. I. du Pont de Nemours and Co. supplied the chemicals that were used in this study and made analyses of soil samples.

* Stationed at East Gulfcoast Research Center, Marianna, Fla.

13 June 1955

Sound of Boiling

An interest in the sound of boiling liquids has been apparent for years. Chemical plant operators in charge of evaporators and reboilers sometimes judge the performance of their equipment by the noise emitted. A general superstition is that the louder the noise of boiling the better the performance of the equipment. The noise that occurs as a hot metal is quenched in a liquid has received notice. A change in pitch accompanies the drop in temperature (*1*). The noise accompanying the overloading and resulting burnout of electric heaters immersed in water has been reviewed (*2*).

Researchers also occasionally depend on the sound of boiling. When boiling data are obtained, it is important to know which type of boiling is occurring. Boiling can occur by at least three different mechanisms. These are different to the eye and the ear and also in the manner in which the heat transfer depends on the temperature driving force.

The relationship between the heat-transfer rate and the over-all temperature driving force for each type of boiling, with methyl alcohol, is shown in Fig. 1. The short crosslines indicate the boundaries between the types of boiling: nucleate, transition, and film boiling.

Visual studies of the types of boiling have been made with still photography, using exposures of 10^{-6} sec, and with

motion pictures at a speed of 4000 frames/sec (*3*). These studies show, as described here, that the manner of formation of vapor bubbles is entirely different in each of the three types of boiling.

The purpose of the investigation described here (*4*) was to determine how the sound of boiling depends on the type of boiling.

Methyl alcohol was boiled at atmospheric pressure at 148°F in a glass boiler, approximately 1 gal of liquid being employed. Heat was supplied from a horizontal copper bayonet heater 6 in. long and ⅜ in. in diameter. Saturated steam at various pressures condensed inside this heater tube. The methanol vapors passed overhead, where they were condensed and returned to the boiler. Measurements included the heat-transfer rate from the tube to the methanol and also the over-all temperature difference between the steam and the methanol.

The sound measurements were made through a crystal microphone located 6 in. from the boiler wall at the same elevation as the heating tube. Interposed between the boiler wall and the heater tube was 1 in. of liquid methanol. The microphone was mounted directly on a General Radio Co. sound level meter, Type 759-B. This meter indicated the intensity of the total sound in decibels in the frequency range from 25 to 7500 cy/sec.

Preliminary tests showed that the background noise was severe during ordinary working hours. Therefore the final data were obtained late at night when the background noise was not significant.

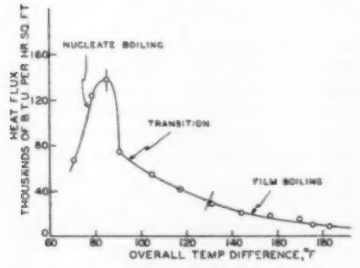

Fig. 1. Boiling curve for methanol.

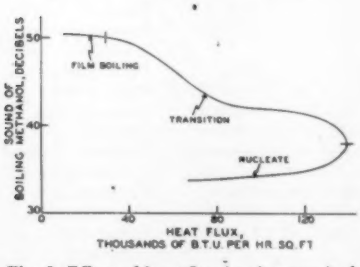

Fig. 2. Effect of heat flux on the sound of boiling methanol.

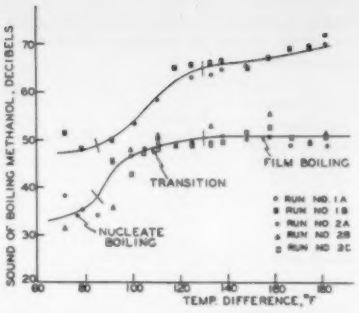

Fig. 3. Effect of temperature driving force on the sound of boiling methanol.

The sound of boiling is indeed a function of the heat-transfer rate during boiling (Fig. 2), but not in the way generally imagined. Contrary to popular opinion, the sound does *not* increase continuously with the heat flux. Inasmuch as the heat-transfer rate is a function of the temperature driving force, the sound is a function also of the temperature difference between the hot solid and the boiling liquid (Fig. 3).

During nucleate boiling any increase in the temperature difference causes an increase in the heat flux and an accompanying increase in the sound intensity. Nucleate boiling—that is, repeated, systematic, bubble formation at specific locations on the hot solid—ceases at a temperature difference of 85°F, and transition boiling exists from this value up to about 130°F. During transition boiling, bubbles form violently and explosively at random locations on the hot tube. The sound increases steadily as the transition region is traversed. However, although the sound increases, the heat flux decreases. Above a temperature difference of 130°F, film boiling occurs and the sound level is rather uniform. During film boiling, the hot solid is blanketed with a film of vapor, and no solid-liquid contact occurs. The heat transfer becomes very poor. A trained listener should be able to distinguish between nucleate boiling and film boiling by ear. He would have difficulty in classifying the transition type of boiling.

Runs 2A, 2B, and 2C (Fig. 3) show that the reproducibility of results, on a single night, was close. A small, but possibly important, difference exists between run 2B and the other two. Run 2B was made with successively increasing values of the temperature difference; runs 2A and 2C were made in the reverse direction. Hysteresis in boiling curves (heat transfer rate versus temperature difference) has been reported by at least one group of observers (*5*). The sound measurements support their observations.

A pertinent fact was discovered by taking data on two different nights. Runs 1A and 1B were taken 5 nights prior to the second series. The relationships are the same qualitatively on the two occasions, but they are different quantitatively. On the second occasion (runs 2A to 2C), great care was taken to make sure that the copper tube was highly polished and that the methanol was well degassed. The sound of boiling is influenced either by the smoothness of the hot solid or by the dissolved gas content of the boiling liquid. Both of these possible causes are suspected. It is known that the heat-transfer rate during boiling is influenced both by the surface texture of the solid (*5*) and by the dissolved gas content of the liquid (*6*). Further tests will be needed to evaluate the individual effects of these two factors.

J. W. Westwater
A. J. Lowery, Jr.
F. S. Pramuk

Division of Chemical Engineering, University of Illinois, Urbana

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20 April 1955

Diffusion of Sodium Ions from Cerebral Tissue in vitro

The diffusion of inorganic ions from pieces of tissue into surrounding stirred aqueous media follows a double exponential time course (Fig. 1), which has been attributed to intracellular-extracellular tissue compartmentation (*1*). This interpretation is brought into question by the present observations (*2*), which afford strong presumptive evidence that, at least in the case of sodium diffusion from pieces of brain tissue *in vitro*, the double exponential curve depends upon other physical factors.

Figure 1 is the semilogarithmic plot of the concentration of radioactive sodium (*3*) remaining in pieces of brain after various times of diffusion. Since each point was established by 10 to 15 experimental determinations, and since each arm of the curve was fixed by several points, there would appear to be little question concerning the double exponential form of the curve. Its significance, nevertheless, is not uniquely determined.

In a general study of the physical laws

governing diffusion of molecules out of a solid into a stirred liquid, March and Weaver (*4*) demonstrated that such curves occur in simple nonorganic physical systems as well as in biological systems. Danckwerts (*5*) similarly demonstrated, on the basis of classical diffusion theory, that diffusion can be described in terms of a series of exponential functions regardless of the shape of the particle from which the diffusion occurs.

The workers cited previously (*1*) have presumed that the first, rapid portion of the curve is related to diffusion from extracellular spaces, while the later, slower part is related to diffusion from intracellular spaces. No such relationship can be inferred from Fig. 1, for only 10 percent of the sodium was present in the rapidly emitted component. The assumption that this sodium is extracellular requires the untenable conclusion that 90 percent of brain sodium is intracellular. (The hypertonicity of the sucrose solution used was not of basic importance because similar percentages of rapidly diffusible sodium were observed with isotonic Ringer's solution as the immersion medium).

Moreover, the percentage of sodium in the rapid component varies with the surface-to-volume ratio, as shown in Table 1, which presents the data from diffusion curves similar to those of Fig. 1; however, the curves were determined with tissue pieces of different surface-to-volume ratios. The percentage diffusing rapidly was found to be directly proportional to surface area. The calculated ratios between surface area and rapid sodium loss (column three of Table 1) were identical within the limits of experimental error; this is further evidence that the rapid fraction of diffusion is directly related to surface area.

Attention is drawn to two physical factors other than intracellular-extracellular tissue compartmentation that may be of

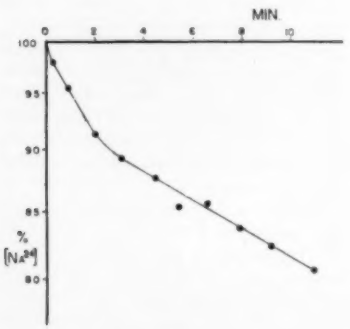

Fig. 1. Semilogarithmic plot of concentration of radiosodium remaining in pieces of hamster brain after various times of diffusion. Medium, 50-percent sucrose in water; average weight of pieces, 230 mg. Each point is the average of 10 to 15 experimental determinations.

Table 1. Effect of surface-to-volume ratio on rapid phase of sodium diffusion in hamster brain.

Approximate surface-to-volume ratio (mm^2/mm^3)	Rapid sodium (%)	Ratio
0.97	8	0.121
1.04	10	0.104
1.83	16	0.114

greater importance in determining the double exponential form of these diffusion curves. First, as mentioned previously, the general physical laws of diffusion out of solid particles give curves similar to those in Fig. 1. Second, microscopically demonstrable shredding and fracturing of the surface of the tissue incident to excision and handling probably increase the effective diffusion area and therefore cause an initially accelerated rate. This suggestion receives additional support from the observation of macroscopic changes in color and fragility of the superficial fraction of a millimeter of tissue. By either mechanism, the slope of the later, slower part of the curve depends upon the rate of diffusion through tissue in the depths of the block. These considerations will be examined in detail in a later publication.

BILL GAROUTTE
ROBERT B. AIRD
Departments of Neurology and *Anatomy, University of California School of Medicine, San Francisco*

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2. This work was supported by the Cox Fund for Medical Research and the Lucie Stern Fund for Research in Epilepsy. We thank I. S. Edelman for his interest and helpful comments. This paper is from a thesis submitted by B. Garoutte in partial fulfillment of the requirements for the Ph.D. degree, University of California.
3. Radioactive sodium (Na^{24}) for this study was made available through the kindness of Kenneth G. Scott and Ernest L. Dobson.
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20 April 1955

Reference Samples of Isotopic Abundance

At the request of the U.S. Geological Survey, the National Bureau of Standards has undertaken a program for the preparation and distribution of reference samples of isotopic abundance in forms suitable for mass spectrometric analysis. The National Bureau of Standards will serve as a clearinghouse for data on the isotopic abundance ratios as measured by cooperating laboratories and will distribute the accumulated data with each sample requested.

Laboratories throughout the world are engaged in mass spectrometer research on variations in natural isotopic abundance using a variety of techniques. Different laboratories are equipped to measure mass spectra of gases, of compounds evaporated from a furnace, and of ions emitted by a hot filament. Different compounds of the element are required for these different techniques. Table 1 lists reference samples that are now available for distribution or will soon be available. The gaseous samples are

Table 1. Reference samples of isotopic abundance.

Element	Compound	Source
H	H_2O	Steam condensate from Potomac River Water
	H_2	From H_2O
D	D_2O	Commercial – 99.8 atom percent D
	D_2	From D_2O
He		Atmosphere (commercial)
Ne		Atmosphere (commercial)
A		Atmosphere (commercial)
Kr		Atmosphere (commercial)
Xe		Atmosphere (commercial)
Li	Spodumene	King's Mountain, N.C.
	Li_2CO_3	Commercial
K	K_2CO_3	Commercial
Rb	Rb_2CO_3	Commercial
Sr	$SrCO_3$	Commercial
Mg	$Mg(OH)_2$	Commercial
Cl	NaCl	Marine (commercial)
Br	NaBr	Marine (commercial)
S	Mineral	Wharton County, Tex.
	SO_2*	Mineral and air
O	O_2*	Air
N	N_2*	From air
Pb	Galena	Ivigtut, Greenland
	PbI_2	From galena
	$Pb(CH_3)_4$*	From galena
Ag	$AgNO_3$	Commercial
Cd	CdI_2	Commercial
Hg†	Element	National Physical Laboratory
B	BF_3	Commercial
Si	SiF_4	Commercial
Ca, C, O	Limestone	Solenhofen, Bavaria

* Will be available in the near future.
† A small sample that was carefully measured by several mass spectrometer laboratories.

equivalent to about 3 ml at 1 atm sealed in break-seal containers. Solid samples are about 0.1 g sealed in vacuum in Pyrex tubes. Liquids are in break-seal tubes.

There is an immediate need to accumulate data on these samples, and laboratories wishing to receive samples and measure them should write to the address given here. These laboratories will be kept informed concerning data obtained by others.

The program, which was initiated with the support of the U.S. Atomic Energy Commission, will continue with preparation of other compounds useful as reference samples and with research on compounds best adapted to isotope abundance measurements.

FRED L. MOHLER
Mass Spectrometry Section, National Bureau of Standards, Washington, D.C.

24 June 1955

Deuteron Bombardment of Oriented Tobacco Mosaic Virus Preparations

Ionizing radiation has been used to study virus size and structure by a series of workers (*1*). The basis of the method of study is the use of energetic local ionizations, distributed in a physically known way, to interfere with virus properties. The method is inferential and relies heavily on the belief that a sensitive region exists and that the volume, area, and thickness of the region can be found by using different kinds of irradiation. This sensitive region is then tentatively identified with some property of the virus.

In the case of tobacco mosaic virus, when the property studied is that of ability to form local lesions on *Nicotiana glutinosa*, the results of radiation studies using deuterons of varying speeds, alpha particles, and fast electrons indicate that the sensitive volume is long and thin, of length 3000 A and diameter 100 A (*2*). This region can be identified with a more sensitive region inside the virus particle proper, but of the entire length of the particle.

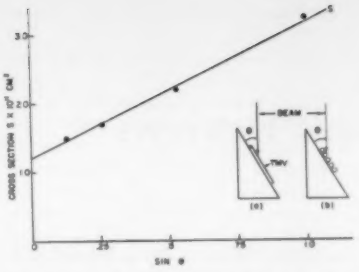

Fig. 1. Plot of the effective sensitive area S against the sine of the angle of exposure of dry tobacco mosaic virus preparations to deuterons. Inset *a*, rods pointed toward the deuteron beam; inset *b*, rods oriented across the beam.

Since it is possible to obtain oriented preparations of tobacco mosaic virus by drying concentrated preparations and gently rocking them back and forth while they are drying, it should be possible to check whether the sensitive region as observed in ionization studies also shows the effect of orientation. If it does not, then any agreement between radiation observations and the actual virus particle is the result of some combination of numerical description with questionable significance; and if it does, it constitutes a valuable confirmation of the validity of the radiation method as a means of studying the size and shape of biological units.

A series of dry tobacco mosaic virus preparations, oriented while drying and checked for orientation by observation of birefringence with polaroids, were bombarded by deuterons of 4-Mev energy (*3*). The preparations were held at angles of 90°, 30°, 15° and 7.5° to the direction of the beam in such a way that the rods were pointed at the deuterons, as shown in Fig. 1, inset *a*. A similar set of preparations served as controls, and the ratio of the amount of activity of each preparation to that of the controls was estimated by counting local lesions by standard techniques. The activity ratio n/n_0 obeys the relationship

$$\ln n/n_0 = -SD$$

in which D is the number of deuterons per square centimeter incident on the preparation, and S is the effective sensitive area. It was found that S varied with the angle of exposure. In Fig. 1 the value of S is plotted against the sine of the angle. It can be seen that a roughly linear relationship holds, so that

$$S = (1.2 + 2.0 \sin \theta) \times 10^{-12} \text{ cm}^2$$

This relationship agrees with the idea of a long and thin sensitive region, which has a maximum cross section when it is lying across the beam direction and a minimum cross section when the deuterons are passing along the long axis.

In order to determine that the observed effect was not caused by beam inhomogeneity, series of preparations oriented across the beam, as shown in Fig. 1, inset *b*, were bombarded at different angles. Here the only effect is to rotate the virus about its long axis without changing its orientation. No effect was observed: a constant value equal to the maximum cross section was found. This, incidentally, shows that no great asymmetry of sensitive material inside the virus can exist.

The afore-mentioned relationship should not be used literally in attempting to determine the size and shape of the sensitive volume of tobacco mosaic virus because it ignores the special properties of ionizing radiation. Thus a densely ionizing particle that misses an end-on virus particle may still produce spurs long enough to cause inactivation from a fair distance. The data are not in disagreement with a sensitive region of length equal to that of the virus particle, 3000 A, and of diameter 100 A. The latter value is less than the accepted width of 160 A.

ERNEST POLLARD
G. F. WHITMORE
Biophysics Department, Yale University, New Haven, Connecticut

References and Notes

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3. This work was aided by a grant from the John A. Hartford Foundation.

18 April 1955

Science seems to me to teach in the highest and strongest manner the great truth which is embodied in the Christian conception of entire surrender to the will of God. Sit down before fact as a little child, be prepared to give up every pre-conceived notion, follow humbly wherever and to whatsoever abysses Nature leads, or you shall learn nothing. I have only begun to learn content and peace of mind since I have resolved, at all risks, to do this.—HUXLEY.

Book Reviews

Advances in Protein Chemistry. vol. IX. M. L. Anson, Kenneth Bailey, and John T. Edsall, Eds. Academic Press, New York, 1954. viii + 542 pp. Illus. $10.50.

The current volume of *Advances in Protein Chemistry* contains eight reviews that are a substantial addition to the excellent account of the proteins that this series has presented. The first two chapters are concerned with physiological aspects of proteins and amino acids. In these H. V. R. Arnstein discusses the metabolic relationships of glycine, and Chapman and Synge review the protein metabolism of ruminants. The following six chapters either consider the properties of proteins that can be related to their structure or deal with the chemistry of substances derived from proteins. They are thus more in keeping with what I expect from the *Advances* than the first two chapters are.

A diverse literature on the chemical and biological methods of resolving racemic amino acids has been usefully summarized by J. Greenstein. The survey of naturally occurring trypsin inhibitors by Laskowski and Laskowski brings out the dissimilarities in the nature of the protein substances responsible for this activity. In reviewing the keratins, Ward and Lundgren have considered the formation and morphological arrangement of keratinaceous structures as well as the chemical and physical properties of these proteins. The molecular structure of simple substances with peptide bonds and other similarities to proteins is discussed by Mizushima.

A comprehensive account of protein-protein interactions is presented by David Waugh. The discussion covers a survey of the forces responsible for molecular stability and interaction, the development of a model of the native protein, a summary of 15 specific cases of interaction and denaturation, and a discussion that relates some of the general aspects of these cases to the model. The chief feature of Waugh's model is a modern version of the nonpolar core or "internal volume" of the protein molecule. This assumption is interpreted in some detail in terms of the α-helix. The model is useful as an attempt to relate the α-helix to other characteristics of the structure of globular proteins and is helpful as a basis for discussing interaction and denaturation. It must be admitted, however, that the experimentally observable aspects of these phenomena do not provide as critical a test as might be wished of the details of the proposed model. The book is concluded by an excellent summary and discussion of the behavior of proteins at interfaces by Cheesman and Davies.

ROBERT C. WARNER
Department of Biochemistry, New York University, College of Medicine

Marine Shells of the Western Coast of Florida. Louise M. Perry and Jeanne S. Schwengel. Paleontological Research Institution, Ithaca, N.Y., 1955. 318 pp. Illus. Paper, $6; cloth, $7.

In 1940 Louise Perry provided the first serious attempt to monograph the mollusks of a small regional area anywhere south of New York. Her student, Jeanne S. Schwengel, has revised the earlier work, added several more species to the record and furnished further details on early life-histories of many species. There are 174 pages of systematic descriptions followed by 55 full-page plates. The illustrations are almost all from photographs of freshly collected material and in every instance indicate the natural size of the specimen. It will be a useful reference book for those who collect shells on Florida's Gulf Coast, but its binding is not likely to last long under field conditions.

LORUS J. and MARGERY MILNE
Department of Zoology, University of New Hampshire

Applied X-rays. George L. Clark. International Series in Pure and Applied Physics, McGraw-Hill, New York–London, ed. 4, 1955. ix + 843 pp. Illus. $12.50.

Here is a book that will draw criticism from some specialists but will be praised by more educators. It covers a very wide range of topics, each one of which is so highly developed today that not less than a dozen experts could cover all with real authority. By way of illustration, perhaps a fifth of the pages are concerned with diffraction studies of polycrystalline materials. This phase of applied x-rays alone has recently been covered by a volume of more than 700 pages, issued by the British Institute of Physics, with three editors and 29 authors, all British [H. S. Peiser, H. P. Rooksby, A. J. C. Wilson, Eds., *X-ray Diffraction by Polycrystalline Materials*, Institute of Physics, London, 1955]. It can justifiably be said of the latter very useful book that not more than half of the chapters were written by men with the greatest experience and ability in the field concerned, because not all of these reside in Great Britain; and this fact is apparent to specialists. What, then, can be expected of a volume of roughly equivalent length, written by a single worker but with a scope at least 5 times as great?

It is clear, at the outset, that G. L. Clark's work is not intended for specialists or experts. For the latter, the author himself recommends "the clinical approach," of which the afore-mentioned British work is an example. A senior undergraduate, or a young graduate student, will find in this latest edition of *Applied X-rays* the same soundly enthusiastic incitement to interest in the manifold applications of x-rays in science and industry that characterized the earlier editions of the work. Clark is a pioneer enthusiast. I recall my own reading, as an undergraduate in 1931, of the first edition, published in 1927. I record with deep gratitude the fact that it was largely as a consequence of my reading of the 1932 edition, along with Meyer and Mark's 1930 volume on the structures of high polymers [K. H. Meyer and H. Mark, *Der Aufbau der hochpolymeren organischen Naturstoffe*, Akad. Verlag., Leipzig, 1930], that I decided to develop a deeper understanding of x-rays as a tool for the study of the atomic structures of materials. I gathered more than mere enthusiasm from Clark's writings; I learned a very great deal about what x-rays could reveal concerning the structure of matter and something of the problems that still awaited solution.

Here, in the fourth edition, is an in-the-main up-to-date comprehensive introduction to the present state of x-ray applications. Every chapter is a useful starting point for a student or other nonspecialist. The bibliographies in and at the end of each chapter cover the fundamentals and much of the special literature in the special fields concerned.

This is perhaps the last time that an author can attempt to include so much of the details of applied x-rays in a single volume. Information and experience are accumulating too fast. One is appalled

to consider what the subject must include in another decade; and how will our students' students cope with the material available a generation from now?

Surely the most difficult feeling one should try to instill in a graduate student is a grasp of where the general development of a field stands, and where he might start his own research. Clark has accomplished what few of us would have either the courage or the ability to begin: a broad and yet a detailed summary of the uses of x-rays. His knowledge, enthusiasm, and care will be of great value to our students. Some chapters, such as the one on the chemical effects of x-rays, summarize information not as yet collected elsewhere and so will be useful to a larger group of readers.

The volume has the usual excellent format of the *International Series*.

RAY PEPINSKY
Pennsylvania State University

Vorlesungen über Differential- und Integralrechnung. Alexander Ostrowski. vol. 1 (1945) *Funktionen einer Variablen*, xii + 373 pp., F. 36.40. vol. 2 (1951) *Differentialrechnung auf dem Gebiete mehrerer Variablen*, 484 pp., F. 69.70. vol. 3 (1954) *Integralrechnung auf dem Gebiete mehrerer Variablen*, 475 pp., F. 78. Birkhäuser, Basel.

This full-scale treatise on the calculus represents an extended form of lectures given by Ostrowski during the past 20 years in Basel. The scope is so large that it covers a good part of the material studied in American colleges in all 4 years.

The first volume presents the key notions of differential and integral calculus of functions of one variable. The emphasis is on gaining an intuitive feeling, and, although rigor is stressed, the proofs of many fundamental theorems are postponed to the later volumes.

The second volume is devoted to the differential calculus of functions of several variables. This is prefaced by a thorough discussion of point sets, with proofs of such theorems as that of Heine and Borel. Extensive applications of the calculus to differential geometry are given in concluding chapters.

The third volume goes quite deeply into the theory of integration. In particular, double integrals are defined for bounded regions G having a null set as boundary and for functions bounded in G and continuous except for a null set; null sets are understood in the sense of Jordan (based on finite coverings) and the integral is obtained as a limit of Riemann sums. Further topics studied are line and surface integrals, substitution in multiple integrals, improper multiple integrals, special functions defined by integrals, and Fourier series and integrals.

The most striking feature of this work is its extreme thoroughness. For each topic a very careful foundation is laid, the standard theorems are established, and then a study is made of many refinements of the theory; for example, the section on integration by partial fractions leads up to the theorem of Ostogradski that the rational terms of the integral are obtainable by rational operations on the coefficients. The refinements are further pursued in the exercises that occupy almost one-fourth of the work. The great value of these would be much enhanced by appendage of "solutions"; the author states his intention of providing them in a separate publication.

The three-volume work stands as a major contribution to the textbook literature, and it will also be of much value as a reference work for those interested in classical analysis.

WILFRED KAPLAN
Department of Mathematics,
University of Michigan

Acetylenic Compounds in Organic Synthesis. R. A. Raphael. Academic Press, New York; Butterworths, London, 1954. xii + 219 pp. $6.20.

The chemistry of acetylenic compounds has developed rapidly in recent years. A feature of this expansion has been the wide application of these compounds in the synthesis of many more complicated unsaturated compounds and especially of naturally occurring substances. R. A. Raphael is particularly well suited for the task of summarizing these recent advances critically and from a practical viewpoint, because he has been closely associated with the main currents of research in acetylene chemistry for the past 10 years, has had wide experience with these compounds, and has contributed a number of notable syntheses that make use of acetylenic compounds; methods for carbohydrates, polyhydric alcohols, unsaturated fatty acids, and penicillic acid may be mentioned.

This volume is divided conveniently into a general section on the preparation and properties of acetylenes, a series of chapters on the synthesis of aliphatic compounds, conjugated systems including allenes, carbocyclic compounds and heterocyclic derivatives, and a final section on practical techniques. There are frequent references to unpublished material. Critical descriptions of the best procedures are given, and the book will be invaluable to the synthetic organic chemist who has only a general familiarity with acetylene chemistry and wants to choose the most convenient method for a synthesis involving an acetylene. Many unusual reactions offering wide possibilities for development are mentioned, and the volume will be interesting reading for all organic chemists, including the rising generation of mechanism-minded individuals who will encounter many unexplained transformations.

THOMAS L. JACOBS
Department of Chemistry,
University of California, Los Angeles

Lectures on Partial Differential Equations. I. G. Petrovsky. Trans. by A. Shenitzer. Interscience, New York–London, 1st English ed., 1954. x + 245 pp. Illus. $5.75.

The theory of partial differential equations is almost as old as the calculus itself but is still in the process of rapid development. The interest in this theory is twofold: it is an important part of mathematical analysis and is also a basic tool in the rational description of natural processes. The literature of the subject is extremely voluminous, but there was a definite need for a short introductory textbook. The present book fills this need admirably.

I. G. Petrovsky is one of the most eminent representatives of the brilliant mathematical tradition of Russia and has contributed significantly to the theory of partial differential equations. This book is based on lectures given at the Moscow State University. It is remarkable that the author succeeded in conveying to the reader some of the basic ideas of a far-flung mathematical discipline in only 245 pages. The book is written with a high standard of rigor; at the same time the connection with physics, which provides the motivation for much of the theory, is emphasized throughout.

The first chapter contains examples of partial differential equations arising in physics, the fundamental Cauchy-Kowalewski theorem, and the classification of linear equations of second order. The second chapter, the largest and most original in the book, deals with hyperbolic equations. The Cauchy problem in the domain of nonanalytic functions and the theory of vibrations of bounded bodies are discussed. The chapter on elliptic equations (Chap. 3) contains a thorough description of various methods for solving the first and second boundary value problems. The final chapter on parabolic equations is much shorter but provides an adequate introduction.

In the body of the text the author dis-

cusses primarily the classical equations of mathematical physics. But he stresses the methods that are applicable to more general cases and concludes each chapter with a brief summary of recent work. It should be mentioned that these summaries reflect almost exclusively the important work done in Russia.

The book can be highly recommended as a textbook for first-year graduate courses and for self-study. A reader who has worked his way through this book will be prepared to read more voluminous monographs, such as the classical *Courant-Hilbert,* and current literature.

LIPMAN BERS
Institute of Mathematical Sciences, New York University

A Symposium on Amino Acid Metabolism. Sponsored by McCollum-Pratt Inst. of Johns Hopkins Univ. William D. McElroy and H. Bentley Glass, Eds. Johns Hopkins Press, Baltimore, 1955. xvi + 1048 pp. Illus. $12.50.

The nature of this book is well epitomized in the first paragraph, page 950, of a summary chapter by Bentley Glass: "It must be admitted that the treatment of amino acids in many extensively used textbooks of biochemistry is woefully inadequate and misleading. There are generally said to be 19 (or 21), or maybe about 25, naturally occurring amino acids, although the number now known actually exceeds twice that many. Very little is said about the synthesis of amino acids, only generalities are stated in regard to protein synthesis, and no over-all view of the reactions of amino acids leading to the production of other amino acids, of peptides, of excretory products, or of other compounds is supplied. Of the 'general reactions' of amino acids, deamination receives the fullest recognition, probably because of its importance in the formation of ammonia and the ultimate production of urea. Decarboxylation is scarcely mentioned; transamination and transmethylation are beginning to be regarded as possibly of some future importance; while peptide and protein syntheses are customarily honored with a few generalities. A few works have begun to portray the field more adequately and to orient students in this obviously key area. Yet the time is surely ripe for a major revision and reorganization of our thinking about amino acid metabolism. Th current McCollum-Pratt Symposium has undertaken to lay the basis for that."

The book consists of 58 original papers with discussion by participants other than the authors. The authors are in general the leading exponents of research in this field and the book may, on the whole, be accepted as authoritative. The exposition of the subject is extensive but not complete. The general student of biochemistry will be rewarded if he is prepared to devote several days to careful study of the text. The book's principal use will be as a convenient reference for the specialist in amino acid research, a purpose that will be greatly aided by its excellent author and subject indexes.

R. R. WILLIAMS
Williams-Waterman Fund Research Corporation, New York

Abstract Bibliography of Cotton Breeding and Genetics, 1900–1950. R. L. Knight. Tech. Communication 17, Commonwealth Bureau of Plant Breeding and Genetics. Commonwealth Agricultural Bureaux, Farnham Royal, Bucks, England, 1955. 256 pp. 21s.

This volume, containing the abstracts of 1191 articles on cotton breeding and genetics, will be extremely useful to workers in the field. R. L. Knight has done an excellent job of abstracting the various articles, and he has made an effort to include every major scientific paper on the subject published between 1900 and 1950. Our files of United States literature in the field of cotton breeding and genetics have been checked against Knight's list and the only striking omission found was J. O. Ware's résumé on cotton breeding in the U.S. Department of Agriculture Yearbook for 1936. It is felt that the book would have been improved if general references and review articles had been listed separately from original contributions.

Three useful appendixes are given in this book: (i) The genome of *Gossypium,* (ii) a gene list for *Gossypium,* and (iii) gene linkage. Workers in the field will be grateful to Knight for bringing up to date the gene list for *Gossypium,* inasmuch as this has not been done since Hutchinson and Silow published a similar list in 1939.

THOMAS KERR
Agricultural Research Service, U.S. Department of Agriculture

Quantitative Methods in Histology and Microscopic Histochemistry. Olavi Eranko. Karger, Basel; Little, Brown, Boston, 1955. 160 pp. Illus. F. 19.75.

The title of this book is perhaps misleading, because the text is concerned with the mathematical appraisal of variation and selection of material to obtain statistically valid numerical expressions of prevalence of histochemical, tinctorial, or strictly morphologic components of tissues rather than with methods of quantitative microchemical analysis.

The book covers well, in lucid language, an area in histochemical investigation that has provoked much discussion in past meetings but has hitherto evoked no comprehensive treatment.

The table of contents is comprehensive and outlines well the real content of the book. The relationship of mathematical quantitation to selection of material, to ultracentrifugation, physical observation methods, staining and histochemical reactions, relative volume area and number estimation, absorption photometry, and statistical analysis of results is discussed.

The book should serve to introduce students and investigators to the application of numerical evaluation to histochemical investigation.

R. D. LILLIE
Laboratory of Pathology and Histochemistry, National Institutes of Health

Variable Stars and Galactic Structure. Cecelia Payne-Gaposchkin. Athlone Press, Univ. of London, 1954. xii + 116 pp. $3.50 (U.S. Distrib.: de Graff, New York 10).

During the past 30 years Cecilia Payne-Gaposchkin has written three major monographs, in addition to several smaller books and a large number of research articles. Her doctor's thesis, *Stellar Atmospheres* (1925), marked an epoch in astrophysics and interpreted the observational results of stellar spectroscopy in terms of E. A. Milne's theory of stellar atmospheres. In 1930 she published *The Stars of High Luminosity,* which was an extension of her earlier work that profoundly influenced the work of all contemporary astrophysicists. *The Variable Stars* (1938) written in collaboration with her husband, S. Gaposchkin, discussed the physical properties of all groups of variable stars, including those of the eclipsing and nebular types.

The present book is concerned with the intrinsic variables as tools in the study of the structure of our galaxy—the Milky Way. It is the best of her books, and it crams into the space of 116 pages an enormous amount of new research. Mrs. Gaposchkin remarks in the preface: "As a book of this kind is printed, the work that will make it obsolete is being done. Such is the price that must be paid for writing on a subject that is actively advancing, and it calls for no apology." There is no doubt that the appearance of this book will itself stimulate new research and thus accelerate its process of

aging. In some respects, it has even now been superseded by new results. Nevertheless, its main conclusions will stand the test of future research.

Why are the variable stars important in galactic research? The answer to this question is given only by implication in this volume. It has, however, been stated lucidly by B. V. Kukarkin in a Russian book under the title *The Study of the Structure and Evolution of Stellar Systems upon the Basis of our Knowledge of Variable Stars* (Moscow-Leningrad, 1949; this book is now available in a German translation. It is strange that Mrs. Gaposchkin gives no reference to this monograph, which treats the problems of variable stars in much the same manner—except, of course, for some Communist-inspired ideological nonsense that abounds in the introductory and closing pages of the Russian book): (i) The variable stars identify themselves by their light-curves as objects of comparable physical properties. (ii) They can be discovered and investigated with relatively modest instruments; since some groups of variable stars are exceedingly luminous, they can be isolated at great distances from the sun in the Milky Way and in other galaxies. (iii) Their variations—due to pulsations and to explosive processes—provide information regarding the evolutionary processes in all stars. These processes are intimately related to the structure and evolution of galaxies.

A single example (not given in these two books) may suffice to illustrate the third point. Consider the mean density of a star and its evolutionary change. If the evolution proceeds with only a negligible change in mass, as in the case of thermonuclear energy-generation, $\bar{\rho} = \frac{\text{constant}}{R(t)}$. But the radius is very poorly determined from direct observations, and its change with time t cannot be found. But most variable stars obey the universal law of vibrating sysems, $P\sqrt{\bar{\rho}} = \text{constant}$. For many variables the period P is known to a small fraction of 1 sec, and in a few, changes of P amounting to 1 sec/century (when $P \sim 4$ hr) have been definitely established. If these changes in period are systematic in character, they imply a corresponding change in $\bar{\rho}$—with a fantastic degree of precision!

The first chapter, "The galaxy," will be of special interest to nonastronomical readers. It lists all the major "races" of stars, not just those that are characterized by changes of brightness, and it contains estimates of their frequencies relative to the entire disk and halo populations. The second chapter on "The pulsating variable stars" is a summary of our knowledge of the light-curves, radial velocities, and spectral characteristics of the principal groups of intrinsic variables. Mrs. Gaposchkin has omitted the T Tauri stars because "our knowledge of these groups of stars is very fragmentary and permits us to investigate them only in our immediate neighborhood." She does not mention the stars of the β Canis Majoris type. They may turn out to be a particularly valuable tool in the future study of associations of very young stars in the Milky Way and in other galaxies.

The third chapter, "The explosive variables," deals with novae and nova-like stars. The fourth, on "The magnitude scale for variable stars" fixes the scales of intrinsic luminosities for the various sequences of variable stars. It recognizes the change in the distance scale of the galaxies first established by W. Baade in 1952. The fifth chapter, "Distribution of variable stars" contains a cautious discussion of the difficult problem of interstellar absorption.

The sixth chapter is a rather abbreviated treatment of the "Motions of variable stars," and the concluding chapter entitled "Variable stars, galactic structure and evolutionary problems" summarizes the results. It "is an expression of opinion [of the author] and touches upon the important problem of the effective planning of research."

Not all of these chapters will make easy reading for a nonastronomical reader. The text is so concise that many terms that are familiar to every astronomer have not been explained. A physicist may not know what a "Bottlinger diagram" is, and a geologist or chemist may wonder what the 21-cm line of hydrogen is supposed to do for astronomy.

OTTO STRUVE
Berkeley Astronomical Department, University of California

Modern Gas Analysis. Paul W. Mullen. Interscience, New York–London, 1955. ix + 354 pp. Illus. $5.50.

This book on gas analysis is divided into two parts. Part I on "Absorptiometric gas analysis" makes up about 60 percent of the text. Part II on "Instrumental gas analysis" takes the remaining 40 percent.

The book is quite complete; practically all known methods of gas analysis are discussed. It is profusely illustrated, as is shown by the fact that illustrations take up space equivalent to about 15 percent of the total. It is a pocket-size book. These facts indicate that the treatment of topics is necessarily condensed. For example, mass spectrometry is described in some 12 pages of text. In such a condensation, when the field to be covered is very broad, it might have been better to have limited the number of topics rather than to strive for historical and subject completeness.

As a survey of an important field, this work will be useful, but for specific applications the information given in it must be supplemented by other sources.

PAUL FUGASSI
Department of Chemistry, Carnegie Institute of Technology

An Introduction to the Study of Insects. Donald J. Borrer and Dwight M. DeLong. Rinehart, New York, 1954. ix + 1030 pp. Illus. $9.

This volume received one of the most extensive reviews to which a science textbook can be subjected. A panel of entomology professors exhaustively and comparatively discussed it at the December 1954 meetings of the Entomological Society of America's Section A. The authors were present to explain some details of contents and arrangements that were mildly criticized.

The concensus of the panel was that the authors had made a major contribution to entomological education, with a textbook that has a somewhat different approach and is of considerably wider taxonomic coverage than most standard introductory textbooks. The panel's principal criticism related to the type of treatment rather than the quality of the material. Those who contend that ecology, morphology, physiology, and other facets of zoology should be segregated and highlighted, will find this textbook deficient in that respect. What the authors have accomplished so well is to weave information concerning environmental relationships, form, structure, and function of insects in the explanatory matter throughout the chapters related to the individual orders.

The typography is excellent. Its 10-point modern type makes it unusually legible. Illustrations are sharp and clear. Authors of species names are written in full, except the customary abbreviation of Linnaeus. An extensive glossary and an adequate index complete the volume.

Professors of beginners' courses who choose to emphasize the taxonomic end of entomology will find this book ideally suited to their use. It also fits especially well in an undergraduate course in insect taxonomy that emphasizes field collection, identification, and preservation of insects. Professors already using it have reported that the keys are excellent, key characters very well illustrated, and students have little difficulty in determining what is meant by a given character. Students can get a close and intimate acquaintance with each insect family from this book. Students have also expressed much interest in the section on each insect order that describes methods of collecting and preserving insects of that

order. A separate chapter on "Insect study activities and projects" describes many basic techniques of insect rearing and study that could be quite valuable in arousing an interest in insect research.

RALPH W. SHERMAN
Agricultural Research Service, USDA

An Annotated Bibliography of Submarine Technical Literature: 1557 to 1953. Committee on Undersea Warfare. National Research Council, Washington, D.C., 1954. xiii + 261 pp. Paper, $1.50.

Divided into eight sections, this bibliography of unclassified material concerning submarine development is the first compilation of such data since World War I. The first section, which embodies material related to nontechnical and historical data, is followed by sections that are technical and specific. The classifications within the sections are further divided by subheadings. For example, section 6, "The submarine in war," has two subheadings: "Submarine warfare operations" and "Effectiveness and potentialities." The first of these has four subheadings that give the data in the time sequence of: prior to 1914; 1914–18, 1919–38; and 1939–52. Under the subheading "1914–1918 inclusive," there are three divisions that group the material according to "General," "Germany," and "Other countries." Titles of foreign documents have been translated as an aid to clarifying the content thereof. There is a table of contents, a list of sources searched, and an author index.

New Books

Industrial and Manufacturing Chemistry. pt. I, *Organic*; ed. 7; 752 pp. pt. II (in 2 vols.), *Inorganic*; ed. 6; 1091 pp. Geoffrey Martin. Philosophical Library, New York, 1955. $50 per set.

Elements of Zoology. Publ. in the Zoological Sciences. Tracy I. Storer and Robert L. Usinger. McGraw-Hill, New York–London, 1955. 552 pp. $5.50.

The Story of Man and the Stars. Patrick Moore. Norton, New York, 1955. 246 pp. $3.95.

Einführung in die Medizinische Psychologie. Für Mediziner und Psychologen. Georg Destunis. De Gruyter, Berlin, 1955. 218 pp. DM. 22.

Microwave Spectroscopy. International Ser. in Pure and Applied Physics. C. H. Townes and A. L. Schawlow. McGraw-Hill, New York–London, 1955. 698 pp. $12.50.

Causalités et accidents de la découverte scientifique. Illustration de quelques étapes caractéristiques de l'évolution des sciences. R. Taton. Masson, Paris, 1955. 168 pp. F. 980.

Electro-Technology. Basic theory and circuit calculations for electrical engineers. M. G. Say. Philosophical Library, New York, 1955. 167 pp. $6.

Industry and Tropical Health: II. Proceedings of the second conference of the Industrial Council for Tropical Health. Harvard School of Public Health, Boston, 1955. 266 pp. $10.

Practicas de Fisiologia. Eduardo Briese. Instituto de Fisiologia, Universidad de los Andes, Merida, Venezuela, 1955. 232 pp.

Crust of the Earth. A symposium. Arie Poldervaart, Ed. Geological Soc. of America, New York, 1955. 762 pp. $6.50.

Problèmes de structures, d'ultrastructures et de fonctions cellulaires. J. André Thomas. Masson, Paris, 1955. 358 pp. Paper, F. 3000.

The Decline of Wisdom. Gabriel Marcel. Philosophical Library, New York, 1955. 56 pp. $2.50.

Pilot Plant Techniques of Submerged Fermentation. Special English edition of Rendiconti Instituto Superiore di Sanita, vol. 17. Fondazione Emanuele Paterno, Rome, 1954 (Distrib. by Interscience, New York). 243 pp. Paper, $8.10.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

Observations de la radiation solaire durant l'éclipse de soleil du 30 juin 1954. Publ. Ser. B, No. 13. R. Dogniaux. 1954. 11 pp. *Les périodes de grands froids en Belgique (1901–1954)*. No. 14. A. Vandenplas. 1954. 29 pp. *Sur les transformations adiabatiques et isobariques dans l'atmosphère*. No. 15. L. Dufour. 1954. 10 pp. *Les aspects météorologique et climatologique des pollutions atmosphériques*. Contrib. No. 16. L. Poncelet. 1954. 15 pp. *L'aéronomie et sa nomenclature*. No. 17. M. Nicolet. 1954. 6 pp. *Etude du climat de la radiation en Belgique*. No. 18. R. Dogniaux. 1954. 54 pp. *Sur l'organisation de la météorologique agricole en Belgique*. No. 19. A. Vandenplas. 1955. 13 pp. Institut Royal Météorologique de Belgique, Brussels.

Current Research in Human Fertility. Papers presented at the 1954 annual conference of the Milbank Memorial Fund. The Fund, New York, 1955. 162 pp. $1.

Scientific Research Activities of Mellon Institute, 1954–1955. Annual Rpt. Ser. No. 42. The Institute, Pittsburgh, Pa., 1955. 53 pp.

Soviet Bloc Economic Activities in the Free World. Mutual Defense Assistance Control Act of 1951. Sixth report to Congress, second half of 1954 (Order from Supt. of Documents, GPO., Washington 25). 100 pp. $0.35.

Paleozoic and Mesozoic Rocks of Gros Ventre, Teton, Hoback, and Snake River Ranges, Wyoming. Geological Soc. of America Mem. 63. Harold R. Wanless, Ralph L. Belknap, and Helen Foster. The Society, New York 27, 1955. 90 pp.

Humanitas. Revista de la facultad de Filosofia y Letras. Universidad Nacional de Tucuman, Argentina, 1954. 525 pp.

Revision of Some Recent Foraminiferal Genera. Smithsonian Misc. Coll. vol. 128, No. 5. Alfred R. Loeblich, Jr., and Helen Tappan. The Institution, Washington, D.C., 1955. 37 pp.

Annual Report (1954) of East Malling Research Station. Kent Incorporated Soc. for Promoting Experiments in Horticulture, Kent, Eng., 1955. 170 pp. $2.

Chronic Pancreatitis and Multiple Sclerosis. E. P. Evans. The author, 1088 Pembina Highway, Fort Garry, Manitoba, Canada, 1955. 16 pp. $1.

Units of Weight and Measure—Definitions and Tables of Equivalents. Misc. Publ. 214. U.S. Dept. of Commerce, Natl. Bur. of Standards, 1955 (Order from Supt. of Documents, GPO, Washington 25). 64 pp. $0.40.

A Radiation Counting System for Recording Rapidly Varying Count Rates. Bull. No. 59. Frances M. Richardson and Harold A. Lamonds. Dept. of Engineering Research, North Carolina State College, Raleigh, 1955. 13 pp. $0.35.

Bird Houses, Baths and Feeding Shelters. How to make and where to place them. Edmund J. Sawyer. Cranbrook Institute of Science, Bloomfield Hills, Mich., 1955. 36 pp. $0.50.

Application of Dimensional Analysis to the Relationship between Velocity of Sound and Physical Properties in Organic Liquids. Eng. Expt. Sta. Ser. No. 100, vol. XLVIII, No. 8. Dudley Thompson and N. N. Bakhshi. Virginia Polytechnic Inst., Blacksburg, 1955. 26 pp.

Studies on the Ecology and Sedimentation of Matsukawa—Ura, Soma City, Fukushima Prefecture (No. 1). Contrib. No. 45 of the Inst. of Geology and Paleontology. 96 pp. *The Science Reports of the Tohoku University*. Ser. 2 (Geology), vol. XXVI. 114 pp. Tohoku Univ., Sendai, Japan, 1955.

Manpower Needs in Highway Engineering. Highway Research Bd. Bull. 106. Natl. Acad. of Sciences–Natl. Research Council, Washington, D.C., 1955. 30 pp. $0.60.

Anales. vol. III, No. 4. Ministerio de Agricultura. Instituto Nacional de Investigaciones Agronomicas, Madrid, 1954. 586 pp.

Supplement to a Survey Report on Human Factors in Undersea Warfare. Panel on Psychology and Physiology of Committee on Undersea Warfare. Natl. Acad. of Sciences–Natl. Research Council, Washington, 1949. 541 pp.

Native Land. National Assoc. of Manufacturers, New York 17, 1955. 46 pp. $0.10.

Notropis Asperifrons, *A New Cyprinid Fish from the Mobile Bay Drainage of Alabama and Georgia, with Studies of Related Species*. Zoology, vol. 3, No. 1. Royal D. Suttkus and Edward C. Raney. Tulane Univ., New Orleans, La., 1955. 33 pp. $0.50.

Mass Transfer—Transport Properties. vol. 151, No. 16. F. J. Van Antwerpen, Ed. American Inst. of Chemical Engineers, New York 36, 1955. 120 pp.

Chemical Composition of Parthian Coins. Numismatic Notes and Monogr. No. 129. Earle R. Caley. American Numismatic Soc., New York, 1955. 104 pp. $2.50.

Scientific Meetings

Peacetime Use of the Atom

Future world energy requirements, the possibilities of meeting these requirements from presently available sources of energy, and the economic costs of meeting some of the requirements by generating electric power with nuclear reactors were some of the topics under discussion during the first 3 days of the International Conference on the Peaceful Uses of Atomic Energy, which convened in Geneva, Switzerland, on 8 Aug. under the auspices of the United Nations.

Participants in the session concerned with world energy requirements during the next 50 years emphasized that they were attempting to forecast an order of magnitude for future needs. N. B. Guyol (U.N.) based his estimates on total useful power consumption in 1952 and past rates of growth of consumption. Useful power consumption in 1952 was equivalent to 10.2×10^9 megawatt hours (Mw hr) of electricity or to the power produced from 3×10^9 tons of coal. The rate of growth of commercial sources of energy has been 3.25 percent per year since 1860, but Guyol stated that this production curve understates the rise in requirements, particularly during recent years, because the efficiency of fuel utilization has increased. Guyol concluded that future growth of energy requirements during periods free from war or depression will take place at a rate between 4 and 6 percent per year. Thus the world will require useful power equivalent to 27×10^9 Mw hr of electricity in 1975 (5.5×10^9 tons of coal) and 84×10^9 Mw hr in 2000 (15×10^9 tons of coal). Guyol estimated that, since the efficiency of fuel use is likely to increase, an increase in fuel production of 3.5 percent per year will be sufficient to meet the new energy requirements.

E. A. G. Robinson and G. H. Daniel (United Kingdom), basing their study on a smaller estimate of future energy needs (equivalent to 7.4×10^9 tons of coal in 2000), considered present known world reserves of coal, oil, natural gas, and hydroelectric capacity. They concluded that hydroelectric plants could supply 0.9×10^9 tons of coal equivalent in 2000; that coal, because its production rate has been increasing very slowly (0.5 percent per year) and because of increased price, could supply only about 2×10^9 tons; and that the demand for oil and natural gas would therefore be about 4.5×10^9 tons of coal equivalent—a demand that would reduce world reserves to within 70 years of exhaustion. Robinson and Daniel said that, under these circumstances, the incentives to expand coal production would be powerful, but that the same incentives would serve equally to stimulate the development of nuclear energy, particularly for generating electricity.

Energy requirements and economic growth were discussed by E. S. Mason (U.S.), who pointed out that the demand for electric power is likely to increase more rapidly than the demand for energy as a whole and that nuclear power can contribute to electric power resources provided that adequate capital is available. Capital requirements for utilization of power, however, are far greater than those for power production. If full advantage of the potentialities of nuclear power is to be taken, the technological development necessary to reduce the cost of producing power from nuclear reactions must be pushed, and means must be found to make this power source available in underdeveloped areas.

Part of this session was devoted to the energy needs and resources of individual countries. Most of the papers demonstrated that these countries—Yugoslavia, Australia, Belgium, Czechoslovakia, Japan, Argentina, and India—would not be able to meet their future energy requirements from presently known conventional sources.

Forecasts of the role of nuclear energy during the next 50 years in France, Canada, the United Kingdom, Norway, Argentina, and the United States were presented in a separate session. Most speakers felt that reactor-produced electric power will seldom be able to compete with hydroelectric power when the latter is available. J. Davis and W. B. Lewis (Canada) suggested that nuclear power plants may be furnishing 10 to 15 percent of Canada's electric generating capacity by 1980 if the electricity can be produced at a cost of 6 to 7 mills/kw hr. K. M. Mayer (U.S.) presented a study of the economic potential of nuclear energy in various regions of the United States. He said that the maximum plausible growth of a nuclear power industry would permit nuclear power plants to provide 1.1, 2.5, 6.0, and 14.8 percent of the total power generation by 1975 for production costs of 9, 8, 7, and 6 mills per kilowatt hour, respectively. Mayer stressed particularly the factors that must be considered and the methods that must be employed in making a realistic appraisal of the economic potential of reactor-produced power. J. Cockcroft (United Kingdom) estimated that the installed electric power capacity of nuclear plants in the United Kingdom will be between 18 and 25 percent of national capacity by 1975.

In accordance with the desires of United Nations officials that considerable emphasis should be given to the economic cost of building and operating nuclear power plants, several papers were devoted to costs and others mentioned them. A paper by J. M. Hill and S. W. Joslin (United Kingdom) and one by W. K. Davis (U.S.) considered the capital investment required for production of nuclear energy. Davis said that cost estimates for power plants of 100- to 200-Mw capacity in the United States now range from $200 to $250 per kilowatt of capacity, whereas coal-fired plants now cost about $150 per kilowatt of capacity.

The most complete analysis of the cost of an operating reactor was presented in a paper prepared by J. R. Dietrich *et al.* (U.S.), who said that total cost of operation of a prototype boiling water reactor that drives a 3500-kw generator was 30 mills/kw hr, of which almost half was charged to capital investment. J. A. Jukes (United Kingdom) presented cost estimates for one of the nuclear power stations that were announced by the British Government last February. For a 150-Mw station driven by a gas-cooled, graphite-moderated reactor, capital costs are expected to be 0.36 pence/kw hr and annual operating costs 0.40 pence/kw hr (total, 9 mills/kw hr). Jukes noted that a coal-fired plant could produce power at 0.60 pence/kw hr, but that credit for the sale of the plutonium produced in the reactor will probably bridge the gap. D. I. Blokhintsev and N. A. Nikolayev (U.S.S.R.) reported that the cost of 1 kw hr of power produced by the 5000-kw station now operating in the Soviet Union "exceeds considerably the average cost of 1 kw hr in powerful heat power stations in the U.S.S.R." (10 kopecks/kw hr). The Soviets estimate that large nuclear power plants will be able to produce power at rates between 10 and 20 kopecks/kw hr. (Ten kopecks is about 25 mills at the official rate of exchange.) J. A. Lane (U.S.) reviewed published estimates of the capital cost of nuclear-electric plants, combined them with projected operating costs, and concluded that nuclear power costs in the range of 4 to 7 mills/kw hr might be realized

within 20 years. Lane discussed the costs of building and operating each of several different types of reactors.

Other topics discussed in the plenary sessions that were held during the first few days of the conference were the administrative and legal problems of the widespread use of high-level radiation sources, including both industrial health and safety and radiological health and safety codes; possible role of thorium in nuclear energy; biological effects of radiation; reactor safety and the location of power reactors; waste disposal in both its short-term and long-term aspects; isotopes in industry, medicine, biology, and agriculture; and experience with operation of nuclear power plants.

Meeting Notes

■ The American Institute of Biological Sciences will meet at Michigan State University, 5–9 Sept. George W. Beadle, Jr., president of the AAAS will be the principal speaker at the general session on 6 Sept., when he will consider the topic "What is a gene?"

During the convention period, 1154 research papers will be presented, and more than 100 speakers will participate in various symposiums. Two special meetings have been scheduled: a symposium on "Cultivated plants of the world" is dedicated to Liberty Hyde Bailey, and one on "Population genetics" is similarly dedicated to Sewall Wright. Other symposiums of general interest are "Modern approaches to problems of differentiations"; "Photorespiration in plants"; Biochemical genetics"; "Antibiotics in agriculture"; "Microscopical science in aquatic biology"; and "Arctic and alpine tundras."

Approximately 2700 biologists are expected to attend these concurrent meetings of 24 professional biological and agricultural societies. The facilities of Michigan State University will be used for society meetings as well as for housing and feeding delegates and their families. The campus will serve as base for a number of field trips into central and northern Michigan. As in the past, the Biological Sciences Exhibit will be an important feature, and this year's exhibit will be larger and more diversified than any displayed at previous AIBS meetings.

■ The Instrument Society of America's 10th annual Instrument-Automation Conference and Exhibit is to be held at the Shrine Exposition Hall and Auditorium in Los Angeles, Calif., 12–16 Sept. Theme of the show this year will be "Instrumentation paces automation."

According to A. O. Beckman, general chairman, the conference and exhibit is expected to be the largest national industry event of its kind ever held in the West. More than 500 manufacturers from many parts of the world have scheduled displays. Industrial leaders from Germany, Japan, England, Scandinavia, and South America, as well as from all over the United States, are planning to attend the meeting. In addition to the exhibit, there will be some 325 technical and clinical sessions.

■ An International Conference on the Use of Antibiotics in Agriculture will be held 19–21 Oct. in Washington, D.C., under the auspices of the National Academy of Sciences–National Research Council with the cooperation of its Agricultural Research Institute. The meeting will be supported by the American Cyanamid Co., Merck and Co., Charles Pfizer and Co., Inc., and E. R. Squibb and Sons.

The role of antibiotics in animal nutrition and food production will become increasingly important as their use is spread throughout the world. Antibiotic treatment of seeds and crops to control certain diseases as well as their use in the commercial processing of both meat and vegetables are receiving more and more attention. These subjects, as well as others, will be covered by the conference, which will be divided into five sessions of 3 hr each dealing with (i) growth response in animals; (ii) special biological problems; (iii) mode of action; (iv) crop usage and food preservation; and (v) public health aspects.

Sixteen scientists from abroad and 28 from the United States have been invited to participate in the program. At each session, two or three critical reviews will be presented and discussed by a panel. Each panel will consist of a moderator, the authors of the reviews, and one or two others. The panel discussion will be followed by a general discussion; finally, the whole session will be summarized by a specially designated participant.

The list of those invited from foreign countries includes: H. D. Branion, head, department of nutrition, Ontario Agricultural College, Guelph, Ont., Canada; Knut Breirem, Institute of Animal Husbandry and Animal Breeding, Agricultural College of Norway, Vollebekk; Johannes Bruggemann, Institute of Physiology and Animal Nutrition, University of Munich, Munich, Germany; Hjalmar Clausen, National Research Institute for Animal Husbandry, Copenhagen, Denmark; Douglas Coles, director of Veterinary Service, P.O. Onderstepoort, Union of South Africa.

John Duckworth, biochemistry department, Rowett Research Institute, Bucksburn, Aberdeenshire, Scotland; Sven Dyrendahl, Royal Veterinary College, Stockholm, Sweden; Andre C. Francois, Centre National de Récherches Zootechniques, Domaine de Vilvert, Jouy en Josas, Seine et Oise, France; E. Freerksen, Institute for Experimental Biology and Medicine, Borstel über Bad Oldesloe, Germany; W. S. Gordon, Agricultural Research Council Field Station, Compton, England.

S. K. Kon, National Institute for Research in Dairying, Shinfield, England; H. R. Marston, division chief, Commonwealth Scientific and Industrial Research Organization, University of Adelaide, Adelaide, South Australia; Francisco Ruiz-Sanchez, Instituto de Patología Infecciosa Experimental, Universidad de Guadalajara, Guadalajara, Jalisco, Mexico; A. D. Sardon, State Animal Health Center, Madrid, Spain; R. L. Squibb, Servicio Cooperativo Interamericano de Agricultura, "La Aurora" Guatemala, Departamenta de Zootecnia, Guatemala, Central America; H. L. A. Tarr, acting director, Pacific Fisheries Experimental Station, Vancouver B.C., Canada.

The meetings will be held in the Jefferson Memorial Auditorium of the U.S. Department of Agriculture at 14 St. and Independence Ave. S.W. Interested scientists are invited to attend. Registration should be made in advance by writing for a registration card to the International Conference on the Use of Antibiotics in Agriculture, National Academy of Sciences–National Research Council, 2101 Constitution Ave. NW, Washington 25, D.C. There is no registration fee.

■ A symposium on the Physiopathology of the Reticulo-endothelial System was held 4–8 July at the Centre National de la Récherche Scientifique, Gif sur Yvette, France. This meeting was sponsored by the Council for International Organizations of Medical Sciences, with participation of the Unitarian Service Committee.

Scientists from this country who attended were S. O. Byers, Harold Brunn Institute, San Francisco, Calif.; E. L. Dobson, Donner Laboratory, Berkeley, Calif.; P. F. Hahn, Cancer Research Laboratories, Nashville, Tenn.; J. H. Heller, New England Institute for Medical Research, Ridgefield, Conn.; Lewis Thomas, New York University College of Medicine; and C. A. Doan, Ohio State University College of Medicine.

Forthcoming Events

September

19–23. **Fédération Internationale Pharmaceutique, 16th general assembly, London, Eng. (D. F. Lewis, Secy., Organizing Committee, FIP, 17 Bloomsbury Sq., London W.C.1.)**

20–23. **American Roentgen Ray Soc., Chicago, Ill. (B. R. Young, Germantown Hospital, Philadelphia 44, Pa.)**

20–26. **World Medical Assoc., 2nd con-**

gress, Vienna, Austria. (L. H. Bauer, 345 E. 46 St., New York 17.)

22–23. Symposium on the Less Common Metals, London, Eng. (W. J. Felton, Institution of Mining and Metallurgy, Salisbury House, London, E.C.2.)

23–24. Symposium on the Biologic Effects of Microwaves, Rochester, Minn. (J. F. Herrick, Section of Biophysics, Mayo Clinic, Rochester.)

25–28. American Inst. of Chemical Engineers, Lake Placid, N.Y. (F. J. Van Antwerpen, AICE, 25 W. 45 St., New York.)

26–29. Assoc. of Iron and Steel Engineers, annual, Chicago, Ill. (Secretary, AISE, Empire Bldg., Pittsburgh 22, Pa.)

26–30. International Dairy Federation, annual, Bonn, Germany. (IDF, 154, rue Belliard, Brussels, Belgium.)

26–30. Atomic Industrial Forum and Trade Fair, Washington, D.C. (C. Robbins, 260 Madison Ave., New York 16.)

26–30. Colloquium on Deformation and Flow of Solids, Madrid, Spain. (H. L. Dryden, National Advisory Comm. for Aeronautics, Washington 25.)

26–1. Endocrine Soc., 7th annual postgraduate assembly, Indianapolis, Ind. (Postgraduate Office, Indiana Univ. School of Medicine, Indianapolis 7.)

27–1. International Symposium on Analogue Computers, Brussels, Belgium. (P. Germain, Institut de Physique Appliquée, Université Librede Bruxelles, Bruxelles.)

28–29. Industrial Electronics Conf., Detroit, Mich. (G. Ferrara, 8106 W. Nine Mile Rd., Oak Park 37, Mich.)

28–30. Mississippi Valley Medical Soc., St. Louis, Mo. (H. Swanberg, 209–224 W.C.U. Bldg., Quincy, Ill.)

29–1. International Soc. of Vegetative Neurology, 6th annual symposium, Strasbourg, France. (R. Fontaine, Univ. of Strasbourg Faculty of Medicine, Strasbourg.)

30. American Medical Writers' Assoc., St. Louis, Mo. (H. Swanberg, 209–224 W.C.U. Bldg., Quincy, Ill.)

30–1. Council for International Organizations of Medical Sciences, 3rd general, Paris, France. (J. F. Delafresnaye, CIOMS, 19, avenue Kléber, Paris 16e.)

30–2. Indiana Geological Field Conf., 8th, Clifty Falls State Park, Ind. (C. F. Deiss, Dept. of Geology, Indiana Univ., Bloomington.)

October

1–9. International Food Fair, Cologne, Germany. (International Trade Fair Staff, USDA, Washington 25.)

3–6. Soc. of Exploration Geophysicists, 25th annual, Denver, Colo. (C. Campbell, SEG, 624 S. Cheyenne, Tulsa, Okla.)

3–7. American Inst. of Electrical Engineers, fall general, Chicago, Ill. (N. S. Hibshem, 33 W. 39 St., New York 18.)

4–6. American Meteorological Soc., Stillwater, Okla. (K. C. Spengler, 3 Joy St., Boston 8, Mass.)

4–6. International Assoc. of Milk and Food Sanitarians, Augusta, Ga. (H. L. Thomasson, IAMFS, Box 437, Shelbyville, Ind.)

6–8. Optical Soc. of America, Pittsburgh, Pa. (A. C. Hardy, Room 8-203, Massachusetts Inst. of Technology, Cambridge 39.)

6–8. Soc. of Industrial Designers, 11th annual, Washington, D.C. (S. G. Swing, SID, 48 E. 49th St., New York 17.)

9–13. Electrochemical Soc., Pittsburgh, Pa. (H. B. Linford, 216 W. 102 St., New York 25.)

9–14. American Acad. of Ophthalmology and Otolaryngology, Chicago, Ill. (W. L. Benedict, 100 First Avenue Bldg., Rochester, Minn.)

10–12. American Acad. for Cerebral Palsy, annual, Memphis, Tenn. (R. A. Knight, AACP, 869 Madison Ave., Memphis 3.)

10–12. American Oil Chemists' Soc., Philadelphia, Pa. (Mrs. L. R. Hawkins, AOCS, 35 East Wacker Drive, Chicago 1, Ill.)

10–12. National Prestressed Concrete Short Course, 1st, St. Petersburg, Fla. (A. M. Ozell, Civil Engineering Dept., Univ. of Florida, Gainesville.)

10–13. National Clay Conf., 4th, University Park, Pa. (T. F. Bates, College of Mineral Industries, Pennsylvania State Univ., University Park.)

10–21. New York Acad. of Medicine Graduate Fortnight on Problems of Aging, New York (R. L. Craig, 2 East 103 St., New York 29.)

11. Illinois State Geological Survey, 50th anniversary, Urbana, Ill. (J. C. Frye, 121 Natural Resources Bldg., Univ. of Illinois, Urbana.)

12–13. Symposium on Phospholipids, London, Ontario. (R. J. Rossiter, Dept. of Biochemistry, Univ. of Western Ontario, London, Ont.)

13. Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, 4800 S. Richmond, Chicago 32.)

13–15. Indiana Acad. of Science, Notre Dame. (W. A. Daily, Eli Lilly and Co., 740 South Alabama St., Indianapolis 6, Ind.)

13–15. Canadian Physiological Soc., annual, London, Ontario. (J. M. R. Beveridge, Dept. of Biochemistry, Queen's Univ., Kingston, Ont.)

14–15. National Soc. of Professional Engineers, Memphis, Tenn. (K. E. Trombley, NSPE, 1121 15 St., NW, Washington 5.)

16. American College of Dentists, San Francisco, Calif. (O. W. Brandhorst, 4221 Lindell Blvd., St. Louis, Mo.)

16–19. Soc. of American Foresters, Portland, Ore. (H. Clepper, 425 Mills Bldg., Washington 6.)

17–19. Detroit Institute of Cancer Research, 8th annual, Detroit, Mich. (Wm. L. Simpson, 4811 John R St., Detroit 1.)

17–20. American Dental Assoc., annual, San Francisco, Calif. (H. Hillenbrand, 222 E. Superior St., Chicago 11.)

17–21. American Soc. of Civil Engineers, New York, N.Y. (W. N. Carey, ASCE, 33 W. 39 St., New York 18.)

17–21. National Metal Exposition and Cong., Philadelphia, Pa. (C. L. Wells, 7301 Euclid Ave., Cleveland 3, Ohio.)

18. American Soc. of Safety Engineers, annual, Chicago, Ill. (J. B. Johnson, 425 N. Michigan Ave., Chicago 11.)

18. Oak Ridge Inst. of Nuclear Studies, council meeting, Oak Ridge, Tenn. (W. G. Pollard, P. O. Box 117, Oak Ridge.)

18–19. National Acad. of Economics and Political Science, Washington, D.C. (D. P. Ray, Hall of Government, George Washington Univ., Washington 6.)

18–20. Entomological Soc. of Canada and the Acadian Entomological Soc., annual joint meeting, Fredericton, New Brunswick. (R. H. Wigmore, Science Service Bldg., Ottawa, Canada.)

18–21. American Dietetic Assoc., annual, St. Louis, Mo. (R. M. Yakel, ADA, 620 N. Michigan Ave., Chicago 11, Ill.)

19–21. Symposium on Applications of Radioactivity in Food and Food Processing Industries, Boston, Mass. (W. A. Stenzel, Tracerlab Inc., 130 High St., Boston 10.)

19–21. International Conf. on the Use of Antibiotics in Agriculture, Washington, D.C. (H. I. Cole, National Research Council, Div. of Biology and Agriculture, 2101 Constitution Ave., Washington 25, D.C.)

20–21. National Noise Abatement Symposium, 6th annual, Chicago, Ill. (R. W. Benson, Armour Research Foundation, Illinois Inst. of Technology, Chicago.)

22. American Mathematical Soc., College Park, Md. (AMS, 80 Waterman St., Providence 6, R.I.)

22–24. American Heart Assoc., 28th annual scientific session, New Orleans, La. (Medical Director, AHA, 44 E. 23 St., New York 10.)

24–26. National Conf. on Standards, 6th, Washington, D.C. (G. P. Paine, ASA, 70 E. 45 St., New York 17.)

24–27. International Anesthesia Research Cong., Washington, D.C. (W. Friend, 515 Nome Ave., Akron 20, Ohio.)

24–1. International Council for the Exploration of the Sea, annual, Copenhagen, Denmark. (General Secretary of Council, Charlottenlund Castle, Charlottenlund, Denmark.)

25–30. American Ornithologists' Union, Boston, Mass. (H. F. Mayfield, 2557 Portsmouth Ave., Toledo 13, Ohio.)

27–28. New Mexico Acad. of Science, Albuquerque. (C. C. Hoff, Dept. of Biology, Univ. of New Mexico, Albuquerque.)

27–29. Electron Microscope Soc. of America, University Park, Pa. (Miss J. R. Cooper, General Electric Co., Lamp Div., Nela Park, Cleveland 12, Ohio.)

27–29. Gerontological Soc., Baltimore, Md. (N. W. Shock, Baltimore City Hospitals, Baltimore 24.)

27–29. American Ceramic Soc., 8th Pacific Coast Regional, Seattle, Wash. (C. S. Pearce, 4055 N. High St., Columbus 14, Ohio.)

28–29. Conf. on Rare Earths in Biochemical and Medical Research, Oak Ridge, Tenn. (G. C. Kyker, Oak Ridge Inst. of Nuclear Studies, P.O. Box 117, Oak Ridge.

28–30. American Soc. for Aesthetics, Chicago, Ill. (J. F. White, Western Reserve Univ., Cleveland 6, Ohio.)

31–1. East Coast Conf. on Aeronautical and Navigational Electronics of Inst. of Radio Engineers, Baltimore, Md. (G. R. White, Bendix Radio Div., Bendix Aviation Corp., Towson 4, Md.)

31–5. Conf. on Solar Energy, Scientific

Basis, Tucson, Ariz. (31–1 Oct.); World Symposium on Applied Solar Energy, Phoenix, Ariz. (1–5 Nov.). (M. L. Kastens, Stanford Research Inst., Stanford, Calif.)

November

1–3. Enzymes: Units of Biological Structure and Function, International Symposium, Detroit, Mich. (C. E. Rupe, Henry Ford Hospital, Detroit 2.)

1–5. World Symposium on Applied Solar Energy, Phoenix, Ariz. (M. L. Kastens, Stanford Research Inst., Stanford, Calif.)

2–4. American Documentation Inst., annual, Philadelphia, Pa. (S. Rosenborg, Library of Congress, Washington 25.)

2–4. Society of Rheology, annual, New York. (W. R. Willets, Titanium Pigment Corp., 99 Hudson St., New York 13.)

2–4. Symposium on Antibiotics, 3rd annual, Washington, D.C. (H. Welch, Div. of Antibiotics, Food and Drug Admin., U.S. Dept. of Health, Education, and Welfare, Washington 25.)

2–5. American Soc. of Tropical Medicine and Hygiene, Boston, Mass. (J. E. Larsh, Jr., School of Public Health, Univ. of North Carolina, Chapel Hill.)

3. American Federation for Clinical Research, Midwestern, Chicago, Ill. (R. J. Glaser, Barnes Hospital, 600 S. Kingshighway, St. Louis 10, Mo.)

4–5. Kentucky Academy of Science, Frankfort, Ky. (Mary E. Wharton, Georgetown College, Georgetown, Ky.)

5. Committee for the Scientific Study of Religion, Cambridge, Mass. (R. V. McCann, Andover Hall, Harvard Univ., Cambridge 38.)

6–7. American Soc. for the Study of Arteriosclerosis, 9th annual, Chicago, Ill. (O. J. Pollak, P.O. Box 228, Dover, Del.)

6–13. International Cong. of Allergology, Rio de Janeiro, Brazil. (F. Alves, Avenida Rio Branco 277, 7° andar, Rio de Janeiro.)

7–9. Assoc. of Military Surgeons of the United States 62nd annual, Washington, D.C. (AMSUS, 1726 Eye St., NW, Washington 6.)

7–9. Eastern Joint Computer Conf., AIEE, IRE, ACM, Boston, Mass. (I. Travis, Burroughs Res. Center, Paoli, Pa.)

7–9. Geological Soc. of America, annual, New Orleans, La. (H. R. Aldrich, 419 W. 117 St., New York 27.)

7–9. Mineralogical Soc. of America, New Orleans, La. (C. S. Hurlbut, Jr., 12 Geological Museum, Oxford St., Cambridge 38, Mass.)

7–9. Paleontological Soc., New Orleans, La. (K. E. Caster, Dept. of Geology, Univ. of Cincinnati, Cincinnati 21, Ohio.)

7–9. Soc. of Economic Geologists, New Orleans, La. (O. N. Rove, Union Carbide and Carbon Corp., 30 E. 42 St., New York 17.)

8. Assoc. of Geology Teachers, New Orleans, La. (R. L. Bates, Dept. of Geology, Ohio State Univ., Columbus 10.)

9–13. International Symposium on Tuberculosis in Infancy and Childhood, Denver, Colo. (L. S. Smith, National Jewish Hospital, 3800–4100 E. Colfax Ave., Denver 6.)

10. Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, 4800 S. Richmond, Chicago 32.)

10–11. American Philosophical Soc., Philadelphia, Pa. (L. P. Eisenhart, 104 S. 5 St., Philadelphia 6.)

10–12. American Astronomical Soc., Troy, N.Y. (J. A. Hynek, McMillin Observatory, Ohio State Univ., Columbus 10.)

10–12. American College of Cardiology, 4th, Memphis, Tenn. (P. Reichert, American Coll. of Cardiology, Empire State Bldg., New York 1.)

11–12. Inter-Society Cytology Council, 3rd annual, Cleveland, Ohio. (P. F. Fletcher, 634 N. Grand Ave., St. Louis 3, Mo.)

13–18. American Soc. of Mechanical Engineers, 75th annual, Chicago, Ill. (C. E. Davies, 29 W. 39 St., New York 18.)

14–16. Technical Conf. on Electrical Techniques in Medicine and Biology, 8th annual, Washington, D.C. (T. Rogers, Machlett Laboratories, 1063 Hope St., Springdale, Conn.)

14–17. International Automation Exposition, 2nd, Chicago, Ill. (R. Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Pa.)

14–18. New England Inst. for Hospital Administrators, 7th, Boston, Mass. (D. Conley, ACHA, 620 N. Michigan Ave., Chicago 11, Ill.)

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2. The three-session program of the International Geophysical Year.
3. An AAAS-sponsored "Congress" on the shortage of young scientists and science teachers.
4. Programs of the 17 AAAS sections (symposia and contributed papers).
5. Programs of the more than 60 participating societies.
6. The Special Sessions: AAAS, Academy Conference, Conference on Scientific Editorial Problems, National Geographic Society, Phi Beta Kappa, RESA, Sigma Xi.
7. Details of the Municipal Auditorium—center of the Meeting—and hotels and campuses.
8. Titles of the latest foreign and domestic scientific films to be shown in the AAAS Science Theatre.
9. Exhibitors in the 1955 Annual Exposition of Science and Industry and descriptions of their exhibits.

Directory content

1. AAAS officers, staff, committees for 1955.
2. Complete roll of AAAS presidents and their fields.
3. The more than 265 affiliated organizations.
4. Historical sketch and organization of the Association; the Constitution and Bylaws.
5. Publications of the Association.
6. AAAS Awards and Grants—including all past winners.
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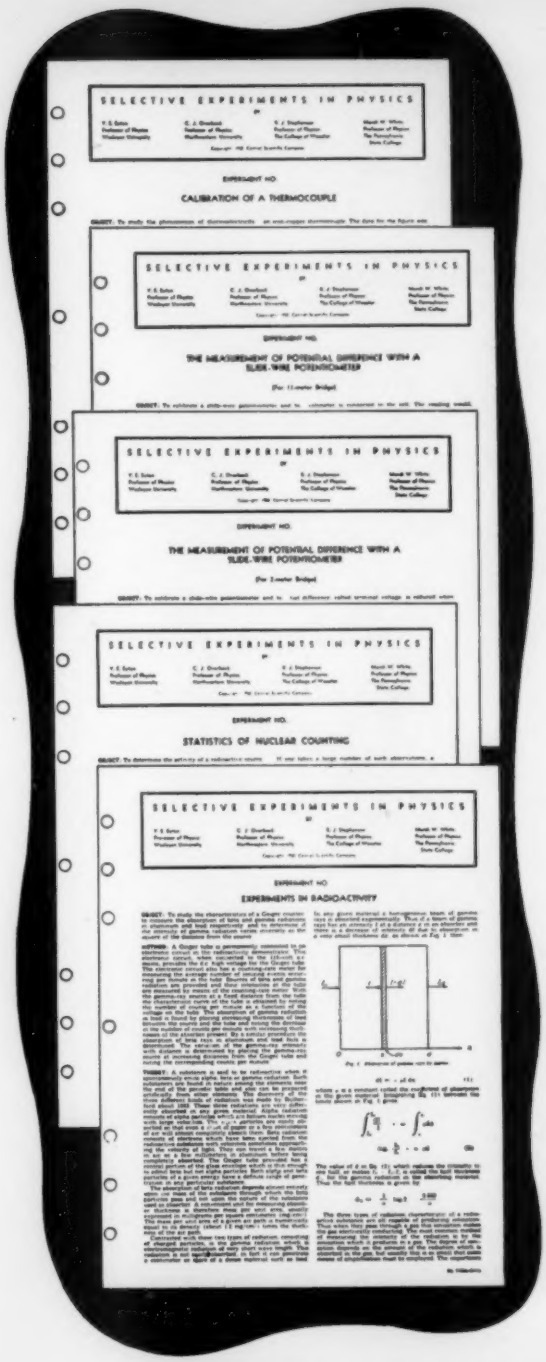

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E 15b	Measurement of Magnetic Field Strength and Magnetic Moment of a Magnet
E 42b	Calibration of a Thermocouple
E 45b	Calibration of an Ammeter and a Voltmeter with a Slide-wire Potentiometer
E 46b	Calibration of a Thermopile with a Slide-wire Potentiometer
E 47b	Measurement of Potential Difference with a 2-Meter, Slide-wire Potentiometer
E 48b	Measurement of Potential Difference with a 11-Meter, Slide-wire Potentiometer
E 49b	Student Potentiometer—Calibration of Ammeter and Voltmeter
E 53b	Ohm's Law
E 55a	Resistors in Series and in Parallel
E 73b	Distribution of Magnetic Lines of Force Near the Surface of a Bar Magnet
E 82b	Reactance; Impedance; Electric Resonance
E 101ab	Construction of Voltmeters and Ammeters
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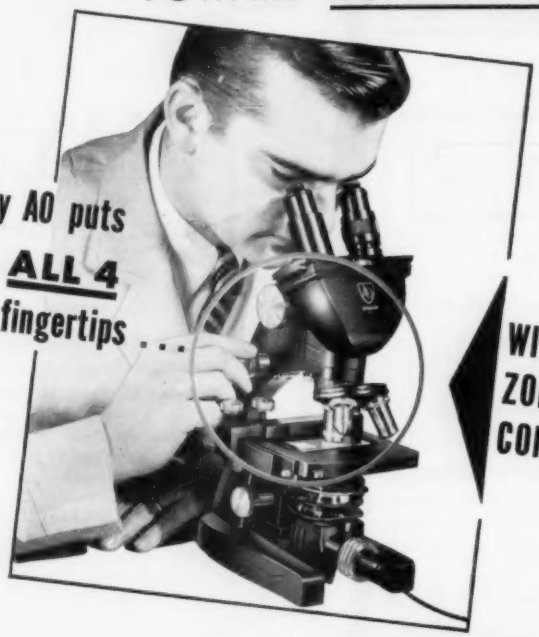

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